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Organization of Moscow Regional Laser Engineering Center Under Way

18610073b Moscow LENINSKOYE ZNAMYA in Russian No 207, 9 Sep 88 p 1

[Article by G. Abilsiitov, general director of the interbranch scientific-technical complex "Industrial Lasers"]

[Abstract] At the USSR Academy of Sciences' Scientific Research Center for Industrial Lasers (NITsTL), a laborious operation for broaching intricately shaped parts with a periodic-pulsed laser has been carried out to orders of a machine-building enterprise.

Various production processes employing laser technology are being perfected by NITsTL in collaboration with the Elektrostal Heavy Machinery Production Association, the Dmitrov Excavator Plant, the Likino Motor Bus Plant and other enterprises. This work is being done on the basis of business contracts in the majority of cases. However, the volume of such contracts at present is clearly insufficient for the purpose of accomplishing work on development of automated laser industrial complexes outfitted with production equipment and microprocessor control systems.

At the present time, the laser technology which is actually used at plants consists chiefly of lasers with capacities of less than 1 kilowatt and without machining attachments and optical systems which convey laser beams to parts that are being machined. High-powered laser technology is not broadly utilized because it is not being produced in sufficient amounts.

NITsTL is developing lasers and comprehensive sets of equipment for laser production processes at the same time. Automated industrial laser complexes for form cutting of sheet materials are under development, as is a multipurpose laser machining center. A number of specialized laser robots employing modern robotic devices are under development. They will permit three-dimensional machining of parts.

Cooperation between the interbranch scientific-technical complexes (MNTK) "Industrial Lasers" and "Rotor" holds much promise. It is proposed to develop rotary assembly lines with laser equipment.

Beginning in 1991, NITsTL, which is the chief organization of the MNTK "Industrial Lasers," proposes to begin industrial production of laser technology for use in production processes, using facilities of its own and enlisting the services of a number of this MNTK's enterprises. The process of transferring NITsTL completely to the system of economic accountability will begin at that moment.

We have proposed creating a regional laser-technology engineering center operating on the principle of self-support. Preparatory work is now in progress so that this center can begin operating next year. It will be equipped with laser technology developed and built at NITsTL. Equipping this center will make it possible to create various laser production processes to orders of industrial enterprises. Through the center, we propose to lease lasers to users and fill enterprises' orders for production of specialized laser technology in the future.

Status of Five Nuclear Power Plants Discussed

18610016 Moscow STROITELNAYA GAZETA in Russian 11 Aug 88 p 1

[Article by special correspondent L. Komarovskiy, Moscow: "Stars in the Haze." A Report from the Selector Conference on AES Startup Generating Units at the USSR Ministry of Energy]

[Text] Monday, 15:00. Business as usual. For many of the management workers in the massive building in Kitayskiy Proyezd the next hour is devoted to the traditional conference call. The client is the USSR Ministry of Atomic Energy and the contractor the USSR Ministry of Energy. These interrogate their departments at five presently introduced nuclear power giants as to the course of the project, clearing up problems and answering questions as they arise. This was not my first time at such events. Today, my task is to ascertain the prospects for placing into service the five "millionaire" power generating units by the end of the year, as scheduled.

The conference call is conducted by assistant director of the chief construction authority (Glavstroy) of the USSR Ministry of Energy, A. Nikulin. The first to respond is the Southern Ukraine AES, assistant director for capital construction V. Solovyev. He quickly and thoroughly discusses what has been done since the previous conference and talks about the problems. They are behind schedule in the trial runs of the fittings. To make up the lost time, the work is being organized in two shifts. This is a definite weak spot for them: while the first shift comprises around 4000 men, the second is 466, and the third no more than 170. Furthermore, the most difficult problem of the station is the equipment. There are five months left until startup, but some of the deliveries are still being held up. They are waiting for five hermetic valves from the Balashikha NPO Kriogenmash, mechanical filters from the Taganrog Boiler Plant, sampling chambers from one of the Kiev enterprises, and much else. The most surprising fact is that some orders have not even been placed yet: for example, facilities for the flushing, purging, and other startup work. I put a question to the microphone: "What are the real prospects for bringing on the third 'millionaire' power generating unit at the Southern Ukraine AES, right now?" "The schedule for completion and startup of the phases has failed, we are 60 days behind schedule. The main reason is nondelivery of equipment. We only received authorization for the trial run on 22 July, and only now are we getting started. We still do not have water in either the reactor department or the machine room, and both technical water systems with the hydrotechnical installations are behind schedule. Consequently, the feasibility of the scheduled deadline is quite problematical at present. Even so, of course, we must surely struggle to meet this deadline."

A thorough answer, but I still do not understand why it is necessary to "struggle" during the work phase? Doesn't this need to "struggle" occur when the yearly plan is being formulated and the individual offices successfully convince the Supreme Soviet that the desirable is feasible, proposing to build as many power generating units as the economy requires, but not as many as they are able to achieve?

But perhaps I exaggerate, and the situation is different at the other stations? Let us see. A. Nikulin asks the construction and operations personnel of the third "millionaire" generating unit of the Balakovo AES to speak. Chief engineer of the station P. Ipatov tells how the handover of facilities is going. In the first half of the year, there was a delay, but by the end of the third quarter this was remedied and the generating unit will meet the startup deadline. In several days, they will begin the cold and hot running-in. The startup is feasible here, although there are also a lot of difficulties. The Tashkent Cable Plant is still "stretching things out," and the products are needed at the construction site.

When Balakovo was done speaking, the Smolensk AES spoke up. A third "millionaire" generating unit is also being introduced here. The chief of the construction authority B. Reva came to the microphone. Here as well, there are a lot of problems involving nondelivery of equipment. Hermetic valves are needed from the PO Penztyazhpromarmatura, transformers from the PO Zaporozhtransformator and the Baku Dry Transformer Plant. Console instruments, voltage stabilizers, and other equipment is lacking. True, there is a current delivery schedule, but who will trust it if all previous ones have failed?

I ask B. Reva for a definite answer: will the third "millionaire" be brought on line at the Smolensk AES? "As chief of construction, I am very doubtful," his shrill voice comes from the loudspeaker. "Given the difficulties with the equipment, the constant reworking of the design documentation, which is still going on, I cannot guarantee it." The others in the room calmly received the answer of Reva. Evidently, it was no surprise to anyone. Nikulin tries without success to contact the Zaporozhye AES. The Rostov AES, where the first "millionaire" power generating unit was supposed to be started up, now comes on the line. This is not one of the successful construction projects. I am aware that even last year it was counted among the startup plants, yet did not come on line. Even now, the situation could be better: only 77 percent of the semiannual plan was met, and several items of the sophisticated basic equipment have not been delivered. And even though everyone understands that, once again, the plant will not generate power this year, it is still reckoned as a startup project and included in the conference call. I cannot understand: whether this is tradition, or inertia, or the familiar reluctance to see the actual situation and report it to the authorities. It is usual for the construction site to send volleys of claims to Moscow and the suppliers, while new deadlines and promises are sent in response. I asked the chief of the construction authority N. Shilo: "How do the workers feel about missing the startup once again?" "They are in a bad mood. There has been one problem after another.

I explain to them. Many of them understand the true situation." Time passes and the session is over. We never did find out about the Zaporozhye AES—no one came on line. Even so, the feeling of irritation is not at all due to this.

Several years ago I wrote that an unrealistic plan is convenient to many parties. The construction workers accept it, since everyone knows that the plan is unrealistic and there will be no harsh penalty if it fails. The executive planning offices, because it creates an appearance of balance in both the national economy and the investment process. The supply agencies, for with an inflated plan it is always possible to hide behind a shortage of resources and equipment. And so on. It is only disadvantageous to the economy, which is forced to run on the realities, and not the ministry fabrications.

Very likely, the times of economic voluntarism and social demagogy are a thing of the past. And today the new class of managers understand that an unrealistic plan demoralizes the people, disturbs the work pace, results in standstills, paid idleness, laxity, and lack of confidence in the ability of one's direct supervisor to organize a normal construction process. But why are we still working with unrealistic plans today? With equipment delivery schedules that are totally groundless and unsupported? Evidently, because the upper levels of management and the commissioning staff of the ministries do not want to accept the simple fact, that one must build and live on one's means.

And so, how many "millionaires" will be introduced presently at the nuclear power plants of the nation? How many new stars will light up on the energy map of the USSR? How many life-giving energy streams will discharge into the energy system, reducing the growing shortage of electricity? Today these stars are being lost in a haze of misunderstanding, lack of coordination, and failure to deliver.

New Directions in Nuclear Generation, Research Urged

18610020 Moscow IZOBRETATEL I RATSIONALIZATOR in Russian No 7, Jul 88 pp 32-35

[Article by V. Yurovitskiy: "Escaping from the Vicious Circle of the Power Industry" with expert commentary by V. Gorbatykh, doctor of technical sciences, docent at the department of nuclear power plants of the Moscow Energy Institute]

[Text]In 1980, the author of this article, a physicist by education and an inventor by character and frame of mind, submitted an application for a new method of energy production, the essence of which is the idea of building nuclear power plants underground. In scope and "audacity" of its claims, this invention (not yet officially acknowledged, of course) seems to be one of the least serious in the eyes of the most serious presentday specialists and quite obvious in the eyes of the future specialists.

Nuclear power stations—only yesterday the acme of perfection, the crown of creation of scientific engineering thought, an object of veneration of the masses—have today become the target of attack on the part of intellectuals, conservationists, and of course the average citizen and ignoramuses who love to criticize technical progress. Yet it is only the inventors, the engineers, and they alone, who are to succeed in overcoming the "crisis" of the nuclear industry, and not by renouncing it, but by further elaboration of its ideas in different, sometimes completely unexpected directions. The nuclear stations being intensively built everywhere today are designed for centuries. And this causes one to think not only of our present day needs. We should already today provide our descendants an absolute guarantee that there will be no other Chernobyl.

But can we do this? The "Greens" in the West are advancing a program—to cease the use of nuclear energy altogether, putting aside the solving of problems which we are not able to solve for the future. Alas, this is no answer. And what of chemical power engineering? Although it does not carry the potential for such disastrous dangers, it does have others: poisoning and contamination of the environment. Furthermore, the reserves of fossil fuel are limited.

Hence the dilemma: it is risky to develop nuclear energy, yet we cannot do without it. Confronted with such contradictions, we are starting to investigate where the logic which historically governed the development of this sector was lost. In this case, one should consider the evolution of the heating appliances. At first, man burned twigs, dry grass, and was skilled in making campfires. Then, when wood became the fuel, the oven was built. Wood has low ash content, and therefore the oven has no system of ash collection and removal. The structure of wood is convenient for water transport. This fuel has a high rate of combustion, and large heat-accumulating structures and a rather elaborate gas ducting system were required. For this reason, the Russian oven is huge.

Coal made the oven much smaller in volume, but because coal ashes have much greater mass, it was necessary to invent a system of air supply and ash removal. The ashpit and fire grate appeared. The combustion products of gas are almost innocuous, so that use of this fuel only posed the problem of mixing it with oxidizer. The gas burner was created. Thus, summing up this brief history, we may say that the fuel led to the design of the "reactor", and not vice versa.

And "macro" power engineering? In the case of coal, a two-circuit electric power steam layout was developed. In the first circuit, coal is burned as fuel. But since the combustion products are heavily contaminated with

solid particles and corrosive chemical compounds, the furnace gases are not used directly as a heat source, but through the intervention of water and steam, to which the gases surrender their energy. These mediating agents are ideal regarding availability and thermodynamic characteristics for the mentioned layout. The process of combustion of coal also has favorable physical-geometrical characteristics—rather large volume of combustion flame, high temperature in the combustion zone, smooth temperature drop in the upper part of the firebox. All this enables a very easy and rational arrangement of the various components transferring energy from the furnace gases to the working substance inside the combustion zone—the economizer, the water preheater, the steam generator, the steam superheater, and so forth. Thus, with coal as fuel, the arrangement of the thermoelectric power station is most feasible and technically sound.

For gas, modern power engineering has been unable to conceive of anything better (at least in the realm of large-scale power engineering) than to use a coal TETs, replacing only the coal combustion layout with gas burners. It is as though one were to install gas burners in a Russian oven and think that this was wonderful. But it is evident that a two-circuit layout is nonsense in the case of gas fuel, since the gas combustion products are themselves a superb thermodynamic substance. Elementary thermodynamic computations show that the efficiency of power plants fired by gas could reach 75 percent or more, instead of the 40-45 percent of the present day. If it were possible to create thermodynamically more efficient ones, and the neutrons absorbed, then the power might initially not only not increase, but actually decrease. This effect is known as the "iodine pit." But an electrical network can change its characteristics extremely fast and unpredictably. The reactor is connected to an unstable load across the turbogenerator, and the slightest fluctuations in the load are instantly transmitted to the nuclear reactor. The disabling of the nuclear steam boiler at Chernobyl was in fact the result of gross regulating actions. In a word, the nuclear reactor has superb reliability, as witnessed by the presence of research reactors in the perimeter of Moscow itself, while the nuclear steam boiler is extremely unreliable and dangerous.

It is declared in the West that Soviet AES are not sufficiently reliable, since they do not have ferroconcrete domes. But one must make it perfectly clear that such dome is a double-edged sword. It is not able to localize a Chernobyl-type accident within itself. The gaseous products of the reaction would still break out, but randomly at the weakest site. The situation is truly nightmarish. It is hard to imagine how such reactor could be shut down, if it is not possible to enter the dome. Western engineers, carried away by domes, are evidently having reservations now after Chernobyl. It was lucky for us that there was a light roof over the Chernobyl reactor, in which a hole was formed: the extinguishing materials were dropped through this hole.

In a word, nuclear power is a very high technology but extremely complicated in engineering and in understanding because it involves substantive and logical technical decisions for the unit. The specific advantages of nuclear fuel are almost completely untouched, nor are its defects neutralized. And the reason for this is perhaps the fact that it was created by Salieri-scientists, instead of Mozart-inventors.

An inventor is sometimes helped by a child's view of things. He likes to imagine nature as a storeroom where everything can be found if one only looks. Man needed long-distance communications, and voila, radio waves exist in nature; man needed a means of leaving the bounds of earth, and voila, reaction propulsion exists in nature; a harmless ocean of energy was needed, and man rummaged around to find nuclear decay.

Thus, having shown that the existing nuclear power engineering, mildly stated, is replete with calamities, but fervently believing that nature in its wisdom will provide an answer even here, let us do a little exploring. If nuclear reactors bring disaster on the surface of earth, it would be well to move them to the moon or to satellites. But this is not yet feasible. Then, perhaps, could they be placed underground? Underground nuclear power stations already exist, e.g., in Norway. But apart from more expensive construction, no one today knows whether such underground AES even have advantages in terms of the safety engineering during a Chernobyl type accident, for example. Moreover, moving the AES underground is a purely mechanical solution, yet we require a new and organic solution that can fully reveal all the merits of nuclear fuel and neutralize its shortcomings in the most natural way.

An AES consists of a nuclear steam boiler, a turbogenerator, and electrical equipment. Clearly, the turbogenerator could not be placed underground, much less the electrical equipment. It is perfectly well to leave them on the surface. Power engineers, and engineers in general, are constantly striving for compactness. But what if we abandon the idea of compactness, which is so enchanting, and "spread out" the AES along the vertical? Say that the nuclear boiler is underground, and everything else on top of it. But by placing the nuclear boiler underground, we immediately bring into play a new physical factor—the force of gravity. For if we shall feed the system with water from the surface, then the pressure at the location of the nuclear reactor will be increased, equaling the weight of the column of liquid, with no pumps whatsoever. The steam pressure at the exit in this case will be equal to the product of the acceleration of gravity by the depth and by the difference in density of water and steam. We now no longer require a pump, which creates the pressure in the system of a conventional AES. Its role will be taken over by the weight of the water, and the gradient of this force will be the source of movement of the water and steam in the system. And if it were possible to move a conventional AES to the

moon, or place it in weightlessness, with no modifications of any kind, then the acceleration of the force of gravity would become the "process parameter"; the pressure in our system would be created automatically, and would not have to be "economized" as is done in conventional AES, where it is created by pumps. Instead of a complicated nuclear steam boiler with a system of piping, we could have a simple nuclear immersion heater. The idea of separating a nuclear power generating layout vertically, using the gravitational forces created by such separation, was first proposed by the author in early 1980. The application for "A method of energy production, geothermal and nuclear power stations" (No. 2880174/06/019851 of 25 Jan 1980), however, was turned down by the VNIIGPE as lacking originality, referring to American patent No. 4022024, which describes a layout for providing electricity to independent consumers, such as farms, by means of a closed circuit with water heated by the sun, there being a small turbine in the circuit, turning an electric generator. One gets the impression that the reviewer simply grabbed the patent lying closest at hand!

Let us begin the specific examination of nuclear power plants using gravitational forces with the simplest version for heat supply. An immersion heater, powered by a nuclear reactor placed alongside, is inserted into a tank with water. Two vertical pipes travel from the tank to the surface. Water arrives through one, and the resulting steam exits to the surface through the other, going directly to the home boilers. The steam is then condensed, gathered in a collector, and returns to the underground tank through a descending channel. The depth of the tank is the process parameter of the layout. For example, if we require steam with pressure of 20 atmospheres in the steam system, the depth of the tank should be 200-220 m. The margin required is only slight, given the enormous difference in density ofwater and steam. In fact, what we have is an ordinary system of geothermal heat supply, except the temperature is created artificially by a nuclear reactor in the earth. In other words, we use nuclear energy to create an artificial geyser.

It is easy to see how simple and reliable this system is. There is not a single mechanical moving device, not a single pump; all movement occurs by virtue of gravitational-thermodynamic forces. Nor do we need a complicated nuclear steam boiler. The nuclear reactor here can be an elementary design, in which the heat transfer is done by means of heat tubes. In order to preclude the possible radioactive contamination of the water in the system, we could provide a radiation uncoupling, i.e., the heat transfer agent of the reactor surrenders heat to an intermediate heat transfer agent, which transmits the heat to the water in the tank. Our residences would receive a fourth-stage heat transfer agent, so that there is no possibility of radiation occurring in the residences.

Let us now imagine that an accident has occurred. It is necessary to mine the reactor. By command or automatically, it is detonated to disperse the core. The reactor is then plugged with cement having the necessary additives, feeding the solution through an emergency pipe joining the reactor chamber to the surface. In such form, with the core broken up into minute particles, the reactor may remain for centuries, presenting no danger whatsoever.Thus, even the slightest chance of any influence on the surface or the underground space in any kind of accident is ruled out. Obviously, even if such cement sarcophagus springs a leak at a certain time, since it will be located in the region of an operating station it would be no major problem to repair it. Any given reactor is suitable for a nuclear gravitational-thermodynamic heating central (NGTC). But the graphite reactors of Chernobyl type will evidently prove best suited. In this case, the power surplus (created when the weather becomes warmer and the heat requirement decreases) could be used to produce secondary nuclear fuel for fast reactors. Thus, the reactors will produce not only heat, but also plutonium. And since the reactor will operate with an exceedingly low-inertia system (the overall volume of water in the circuit will be many thousands of cubic meters), rapid changes are virtually precluded, and a complicated regulating system making use of computer and special complicated control programs are not required. An elementary system of automatic regulation in the form of pressure sensors and a device to control the position of the regulating rods will be entirely adequate. Ultrahigh-power reactors are entirely unnecessary in such layout, because several reactors in no way connected with each other can operate with a single tank if necessary. The standard series of reactors, e.g., the 200 MW reactors, would work fine. A more than modest design would result, compared to the Gigawatt nuclear steam boiler used in present AES.

It is necessary to visit the reactor only for refueling. The rest of the time it can operate underground, automatically controlled. Safety engineering is enhanced. The reactor is inaccessible to both military attack and terrorist actions. Finally, if such reactors are built in poorly developed countries, e.g., as per the MAGATE policy, the agreement could stipulate that the user-country will have no access to the reactor when operating, and the refueling will be done under MAGATE supervision. This entirely eliminates the possible spread of nuclear weapons through nuclear power generation. It is best to carry out the primary processing of the radioactive wastes on site, in underground chambers near the reactor itself. The nonutilized wastes need not be transported anywhere, but can be kept alongside the reactor in a storage department. It will be necessary to store the wastes for hundreds of years. This problem of today's unsupervised radioactive waste dump sites and burials is, I believe, much more easily and reliably solved in the proposed alternative. In our country, the department would be under supervision of the members of the nuclear gravitational heating central, and they can even make repairs if necessary. An absolutely safe gravitational thermal central could be located directly beneath a city center. The NGTC would improve the atmosphere of the cities, since boilers are eliminated. If the NGTC is further

outfitted with a pipe 200 meters in height, during dry weather in the summertime when the need for heat is much reduced, steam could be directed into the pipe. It will condense at the outlet, creating an artificial rain over the city. Thus, in the southern regions of the country, the NGTC could be used to regulate the climate in a city.

In the first phase, the nuclear fuel could be used solely for heating. The production of electricity in nuclear facilities is another matter. Let us see how the principles of vertical separation of a power generating system and use of gravitation as a technological factor would operate in nuclear electric power stations.

The main difference here, from the very outset, is the fact that steam with pressure of 20 atmospheres is not adequate for economical electric power engineering. Modern electric power engineering uses steam with near-critical parameters. The critical pressure of water vapor is around 230 atmospheres, but these atmospheres can be achieved at a depth of 2300 meters. Hence, the technological depth of the nuclear gravitational thermodynamic electricity station (NGTES) should be not 200 meters, but 2000-3000 meters. This, of course, is no small depth. But neither is it fantastic, unreachable by modern mining techniques, given the fact that gold mines 5000 m deep are being operated in South Africa. We may note in passing that the depth of the NGTES on the moon, where the force of gravity is six times less, should be 15 kilometers. Truly, we may again observe with astonishment that Nature has provided us, earthlings, or rather humanity, with excellent opportunities for creation of safe and moderately complicated nuclear power generation.

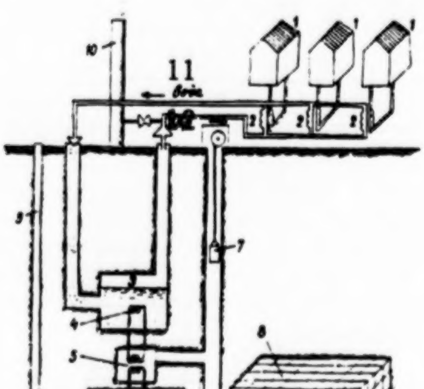

Diagram of a nuclear-gravitational thermal central (NGTC)

Key: 1) Consumers of hot water; 2) Residential boilers; 3) Main tank of system; 4) Immersion heater; 5) Radiation decoupling; 6) Reactor; 7) Elevator; 8) Waste disposal; 9) Emergency reactor shutdown pipe; 10) Municipal irrigation pipe; 11) Water; 12) Steam

Thus, the nuclear gravitational-thermodynamic electricity station will have the same tank as the NGTC, but now located at a depth of 2000-3000 meters. In this tank, by the exact same technique, nuclear immersion heaters can be used to heat the water to boiling. The steam will rise through a vertical pipe to the surface, reaching a steam turbine with connected turbogenerator. The steam then condenses, as usual, in a condenser. Thus, the NGTES is in fact an artificially created geothermal electricity station.

The advantages of the NGTES are simplicity of the reactors, simplicity of the regulation, and safety. The most expensive item of such project is creation of the mine shaft. But even during construction of conventional AES it is necessary to spend an enormous amount of resources on the building, the concrete dome, and so forth. In our case, the expenses for management, safety, losses of farmland, manpower, etc., are greatly diminished. It is difficult to say at present whether the NGTES will be more or less expensive than a conventional AES, but there is no doubt that the operation of the NGTES will be much less costly. And Chernobyl has clearly shown what losses may result from economy measures.

In view of the relatively high startup expenses, virtually independent of the capacity, it is feasible to build ultra-powerful NGTES of 10 GW or more. It will also be

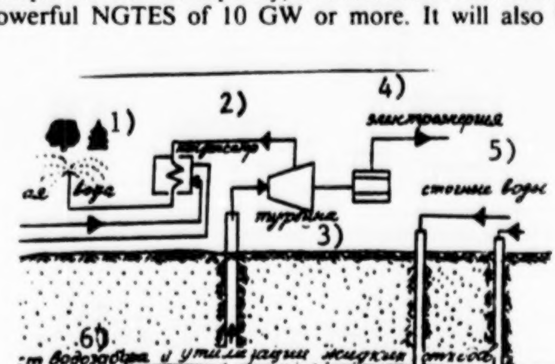

Diagram of a nuclear gravitational-thermodynamic electricity station. The author proposes placing the reactors of such station at a depth of 2000-3000 meters.

Key: 1) Fresh water; 2) Condenser; 3) Turbine; 4) Electricity; 5) Waste waters; 6) Water intake and liquid waste utilization stratum; 7) Mineralized water intake; 8) Zones of future mineral deposits; 9) Reactors; 10) Waste storage department; 11) Sump; 12) Salt solution

advantageous to locate them at the center of economically developed regions, in order to reduce the expenses on transfer of electricity.

Let us mention some other new problems associated with the NGTES. Modern steam boilers place exceptionally high demands on quality of the process water. This is understandable. The water in a steam boiler, after all, travels through tiny tubes several kilometers in length. The cleaning of scale from the interior of these tubes is an exceedingly difficult problem. But in the NGTES we have an immersion heater: the water will wash the heating elements on the outside, and therefore the demands on water quality in the gravitational-thermodynamic channel are drastically reduced. Moreover, it is possible to create an NGTES using mineralized water—brine or underground water. At the outlet, after the condenser, we obtain fresh water. Thus, the NGTES could become an extremely important source of fresh water, and fresh water is becoming a product no less valuable than energy. A 10 GW NGTES could furnish an entire river of fresh water, and this along with the energy. Thus, perhaps, it is better to solve the problem of supplying fresh water to Central Asia not by the hazardous projects of redirecting the northern rivers, but by building NGTES in this region.

The concentrated salt solutions forming during desalination are discharged into an accumulating reservoir, or sump, of rather large size. This is easily created, for example, by means of a peaceful atomic explosion. The water would be periodically pumped from the sump, and these salt solutions could be used in the chemical industry for extraction of valuable components.

Modern technology is creating a large volume of toxic waters, and we do not yet know what to do with them. Whereas the problem is still somewhat manageable with solid waste, the same is not true of liquid waste. The present methods of purification are costly, and often produce poor results. But what if all liquid wastes were pumped into the same stratum from which water is supplied to the NGTES? Contamination of the underground waters? Of course the hydrogeologists will first have to examine these strata carefully, to make sure that they have no hydrodynamic link with the usable subsurface waters. Second, the conical depression formed around the water intake of the NGTES will direct the filtration of these injected waters toward the water intake, and not in a random unregulated direction. Thus, the injected toxic waters will move toward the water intake of the NGTES, undergoing filtration. This is in fact a question of artificial maintenance of stratum pressure by injecting certain agents into the stratum, which is well understood in petroleum mining. And we propose to use liquid wastes as such agent. During this movement into the stratum, they will be purified in large measure, leaving a significant amount of their deleterious admixtures in the stratum. The effectiveness of water purification by filtration movement is confirmed by the practice of pumping seawater into strata for artesian water supply, widely used on a global scale. Finally, the water entering the reservoir of the NGTES would undergo evaporation and final purification. The resulting steam, we may expect, would meet all sanitary norms.

Nuclear power engineering is able to solve two extremely important problems at the same time—production of electricity and fresh water—which is already a magnificent benefit, since it will allow us to irrigate the deserts, provide food for arid regions, and leave the rivers alone. Nuclear power offers an excellent opportunity for radical improvement of the ecological situation, creating reliable means of disposal of toxic liquid wastes.

But what is the ultimate fate of the pollution left behind in the stratum over the centuries? Could we in the final analysis contaminate the subsurface realm? No. By pumping our toxic waters and all our unneeded dross into the strata, we will ultimately create deposits. Artificial, technogenic deposits of minerals, which our descendants will be able to develop, extracting whatever we have not been able to use ourselves. Obviously, in our concern for our descendants, we should right from the start think of ways of facilitating their future work in mining these artificial minerals. For example, we could pump the mercury-containing waters in one spot, the lead-containing in another, and so on. Then, when the time comes to develop these "deposits," our descendants will have a good word to say about our concern for them.

Thus, nuclear power can solve the problem of energy, fresh water, disposal of liquid wastes, and stockpiling for the future that which we cannot utilize today. But this is not all. Why not assemble industries harmful to the ecology in the underground space around the NGTES, operating on cheap and abundant energy, having excellent channels for utilization of wastes, excellent means of underground access. It would be possible to utilize the space down to a depth of 2-3 kilometers, where the ultimate NGTES structures will be situated. Such underground arrangement in many cases would even be cheaper. There is no problem of temperature maintenance and air conditioning, since there is no destructive action of precipitation, acid rain, and temperature change on the walls of the buildings, since there are no buildings per se, but only emptiness. The future may belong to the architecture of "voids", and not the architecture of solids.

The creation of underground industrial centers around the NGTES will invigorate the entire ecological situation on earth. Nature will finally catch a breath from the industrial squeeze, and man will regain possession of the earth for recreation, amusement, and enjoyment.

Such are the prospects for nuclear power, if the "diabolic machine" is set running in the nether regions. Concerning the role of invention in this process, the first priority is to discover new systems of vertical-horizontal transport. Clearly the vertical-transport elevator systems for

underground industrial complexes will not do, because of their small throughput capacity. It is necessary to have such transport system that can first move vertically, for example, and then at any desired point switch to horizontal movement, and the "trains" can be sent one after another along this route, like a conventional railroad. We were the first to release the nuclear jinni from the bottle, creating the nuclear power station. This jinni has punished us in a most terrible way. But perhaps Soviet scientists, engineers, inventors and politicians will now point out the proper path of development of nuclear power?

From the Editors: After the application of Yurovitskiy (25 Jan 1980), similar ideas were published here and there in our press (for example, see MOSKOVSKIYE NOVOSTI of 17 Feb 1988, "Reactors Should be Underground"). We do not know, however, if such ideas were expressed prior to this. Perhaps our readers will inform us.

Expert Commentary:The article is grand, addresses the problem, and the erudition of the author is immense. However, there are several "gaps" in the hypothesis.The "absolute guarantee" propounded at the beginning of the article is a utopia. Even in an underground siting, the likelihood of an accident with emissions exists, although (to be sure) it is less by an order of magnitude, if not more. The temperature of the core of a nuclear reactor is lower than that in the zone of combustion of chemical fuel because of the absence of structural materials able to function for a long time in the environment of the radiation flux.

Accidents at nuclear plants occur because of the personnel disobeying instructions. The engineering itself is not to blame. As for the magnificent role of the Mozart-inventors, these usually provide the principle of operation, but not the layout itself, especially for such complicated devices as an entire AES. One must not contrast science with dilettantism or inspiration. The idea of placing a reactor in orbit around the moon is mistaken, if only from the economic standpoint. It is better to use a geocentric satellite with constant coordinate of positioning above the earth's surface. Solar energy could be converted in such satellite and sent to earth by microwave "transport." Such projects indeed exist. But the specific cost of a "satellite" kilowatt is more than 10,000 rubles, while that of an earth kilowatt from an AES is 250-350 rubles.The USA has abandoned the concept of fast breeder reactors (producing plutonium), precisely because the U.S. government system is not able to supervise where the proprietors are putting the plutonium! So this is a sociopolitical problem as well.

The postulate of the author, that nuclear energy could be directed into production of plutonium when the thermal load is reduced, is not clear. We know that plutonium accumulates by virtue of the neutrons escaping from the reactor. It is possible to separate the neutron fluxes, although we require a neutron source and a channel. But this is no longer a conventional reactor, being instead a more complicated layout with separate zones of fuel fission and neutron capture. How could this be achieved without the "appalling engineering"? Finally, a reactor can only operate on highly pure water. Salt solutions can be evaporated by means of the water heated in the reactor, but only in small proportions (relative to the total flow rate of salt solution), owing to the heavy metal corrosion which reduces the lifetime of the pipes. Thus, in the AES of the city of Shevchenko: the spent turbine steam is partly used for desalination of seawater, but this seawater is not boiled in the reactor itself. If the seawater were pumped into the reactor, the impurities would certainly become radioactive in passing through the core.The author's resentment toward the examiner is startling. Trivial private concerns are not worthy to stand alongside such tremendous problem. Speaking in general, widespread operation of AES should be based on a high culture of management and an understanding of the possible consequences of reckless, insufficiently verified actions.

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21st Century Nuclear Power Plants Discussed

18610033 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 16 Aug 88 p 3

[Interview with A. Rineyskiy, chief of the future projects laboratory of the Power Generation Physics Institute and doctor of technical sciences, conducted by A. Vorobyev, Obninsk, Kaluga Oblast]

[Text] A. Koshelev, an electrician at the Kuybyshev machine plant, writes: "I have heard that a completely new type of reactor has been created in the USA which, as they say, is absolutely safe to operate. Moreover, in emergency situations the chain reaction is automatically quenched—without intervention of people or machinery. Why don't we adopt such reactors?" This is answered by A. Rineyskiy, chief of the future projects laboratory of the Power Generation Physics Institute and doctor of technical sciences.

From the look of it, this would be a so-called integral fast reactor. It has been tested at the Aragon National Laboratory of Chicago University, showing promising results. But such reactors are no novelty to Soviet physicists. The theoretical foundations of their creation were formulated in the investigations of A. Leypunskiy, begun nearly 40 years ago. His ideas were developed within our institute, himself being the scientific director to the very last days of his life. They have also been embodied in the successfully operating "fast" reactors BN-350 on the Mangyshlak peninsula and BN-600 at the Beloyarsk AES in Sverdlovsk oblast. A third, more powerful fast reactor is also being built. Chernobyl has focused the attention of many people on problems of safety of nuclear power plants. In some countries, and even our own, they are categorically demanding a ban on construction of new AES and dismantling of those already operating. Are

there grounds for such extreme measures? How much can we trust the statements of the American specialists as to the absolute safety of the "fast" reactors?

In my opinion, there is mostly fear, emotion, and lack of elementary information in the pronouncements against nuclear plants. One cannot, on account of the miscalculations of people, condemn an engineering concept which may solve the problems of energy and ecological cleanness. It is up to us to make all AES absolutely safe.

In this context, the conclusions of the American specialists are indeed trustworthy. Not without grounds do they assert that an accident similar to Chernobyl or Three Mile Island is theoretically impossible in "fast" reactors. On what is this declaration based? On the results of tests which they have carried out. During this testing, for example, both the nuclear fuel cooling system and the emergency shielding were deliberately shut down at one of the experimental reactors. In other words, with their own hands they created a situation many times more dangerous than Chernobyl. But neither excess heating of the core nor an explosion took place! The reactor shut itself down—smothered itself—with no damage of any kind.

How? We all know that in conventional nuclear reactors the role of the brakes is played by a system of rods of special material, readily absorbing neutrons. In a dangerous situation, these are quickly inserted into the reactor core and quench the chain reaction by reducing the neutron bombardment. But what would occur here?

In these same conventional reactors there is also another system largely responsible for safety. This provides for the circulation of coolant, which carries away the energy produced in the course of the reaction. As a result, to use a metaphor, only a weak flame smolders in the core, and not a blazing nuclear bonfire, which could easily turn into an explosion. Of course, this system could also fail. But no accident would occur if the "brakes" work properly. Only simultaneous failure of both the "brakes" and the coolant circulating system could produce a disaster similar to Chernobyl.

One of the characteristics of the fast reactors is the fact that molten sodium is used instead of water as the coolant in the circulating system. The boiling point of sodium is much higher—around 900 degrees. Accordingly, sodium begins to turn into vapor only at this temperature, raising the pressure inside the reactor and producing the threat of an explosion. Yet no explosion will occur. Long before this, at lower temperatures, the self-heating of the reactor causes the elements of the core to expand. And the increasing volume of the structure results in leakage of neutrons. The reactor "smothers itself", without reaching the critical point.

I see what you mean. It couldn't be simpler! But then the bewildering question arises: Why have not such reactors become common before now?

Simple? Everything becomes simple only when the scientists and engineers begin not only to comprehend, but also to utilize the properties of self-regulation peculiar to a given object. Long ago scientists discovered the capacity of "fast" reactors to "smother themselves." But it took on decisive importance only now, when issues of AES safety have been aggravated to the utmost. Unfortunately, there are also certain drawbacks to these reactors. Compared to those operating at the majority of AES, they are more complicated in structure. The use of liquid sodium creates no small difficulty, and the generated electricity is somewhat more costly. Therefore, the prime interest in them until recently involved the question of production of the nuclear fuel.

Wouldn't this interest decline if the world adopted a firm course of nuclear disarmament? Without bombs, there is enough uranium for nuclear power.

There is also the economic aspect. The types of reactor in use today burn less than one percent of the uranium extracted from the earth. The remaining 99 percent ends up on the dump site. Yet the global reserves of uranium are extremely limited. The fast reactors should also help in solving this problem.

How? As a matter of fact, only fissioning isotopes can be used as nuclear fuel—they produce a nonquenching chain reaction. And only one such isotope exists in nature—uranium 235. But there is less than one percent of this in the uranium mined. The remainder is uranium 238. But if this is put into a "fast" reactor, it will be turned into an excellent raw material for production of another fissioning, but artificial isotope—plutonium. And more of the new fuel is "generated" than is burned. As a result, the overall effectiveness of utilization of the mined fuel is increased by a factor of 50-60!

What radically new ideas were put forth at the Soviet-American seminar recently held at Obninsk?

A number of specialists, for example, cast doubt on the expedience of large nuclear plants. In opposition to this they proposed a modular principle of AES construction, assembling them if you will from smaller-sized units with optimal quantity of generated energy. The American specialists consider such approach highly promising. In the first place, it opens the way to total factory production of a nuclear steam-generating installation consisting of reactor and steam generator. The assembly of such units would substantially reduce the AES construction time and help in solving the security problems. In addition, the servicing of the station is easier and the investment more quickly paid back.

If such major benefits are obvious, then what prevents our building modular reactors?

In the first place, it is necessary to create the necessary production and technological base for fabrication of "fully-unitized" nuclear installations. But it might be

much more difficult to solve a number of problems involving the transport of such oversized freight. In the USA, for example, the railroads are no longer able to handle cargo up to 20 meters in length, more than 6 meters in diameter, or weighing a thousand tons. By using the water-overland routes, the possibilities increase by a factor of one and a half. Our own transportation systems are not yet able to handle such cargo. Thus, expansion of the transportation "bottleneck" is also a step in the direction of the nuclear power industry of the 21st century.

Seepage-Proof Foundations for Nuclear Plants Discussed at Seminar

18610073a Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 221, 24 Sep 88 p 1

[Article by L. Kaybysheva]

[Abstract] "A Wall in the Ground" was the topic of a seminar which has been held at a fair of scientific-technical achievements in construction (NTD-88), at the USSR Exhibition of National Economic Achievements. This seminar dealt with structures which are intended for preventing seepage of liquids, including structures which were built on the territory of the Chernobyl Nuclear Power Station in the summer of 1986. Time has shown that a dense underground shield—a wall in the ground, so to speak—protects the surrounding area excellently against penetration of radioactive waters from a station. At that time, Italian machinery and other equipment was acquired to supplement Soviet-made equipment, in order to expedite the work; the capacities of the Soviet equipment were insufficient for such a large rush job. The All-Union Design-and-Surveying and Scientific Research Institute imeni Zhuk proposed that equipment of a model which it designed long ago be improved for this purpose.

"This set of equipment excavates the ground, lays filling material and tamps it independently," said V. Sheynblyum, chief designer of the equipment. "The specifications of drilling machines which take the place of conventional earth-moving equipment here have no counterparts whatsoever abroad."

Hydro Cutbacks Criticized

18610031 Moscow STROITELNAYA GAZETA in Russian 3, 11 Sep 88 p 2

[Article under the "Social Problem-Solving Panel. Report from the Scene" rubric by K. Kuzmin, chief engineer of the Krasnoyarskgesstroy Construction Authority: "Hydropower Arguments—Isn't It Time to Rethink Their Importance to the Economy?"]

[Text] The article published on 27 August by the Krasnoyarsk journalist V. Komorin, inaugurating a new column in our newspaper, subjected to critical analysis the reasoning behind the design of the new major construction project of Siberia—the Turukhansk GES, and also touched on several points in the overall hydrotechnical construction policy. Today, we continue the dialogue, presenting our readers with a different point of view as to the status and development prospects of this important sector of the economy.

In the documentary film "Plotina" [Dam], there is an episode where a bulldozer tears down a ramshackle house, and the mournful eyes of an old woman appear on the screen. Easy to understand. But for objectivity, it would have been well to also show this woman moving to a new house, where the living conditions cannot even be compared to the former. In other words, idyllic nostalgia for the past must not ignore the need for socioeconomic development. And this is not possible without the power industry, be it thermal, nuclear, or hydro. Let us be clear from the outset: construction of GES is solving the problems of regulating the course of the rivers, rescuing people from the constant flooding, enabling development of irrigated agriculture and (if properly managed) fisheries. Entire regions are being enlivened by the hydro stations. This is the cheapest energy. Compared to thermal power, the situation is as follows: 11 times less people are needed, and it is not necessary to develop the transportation and fueling infrastructure or spend money on their operation. If we could realize 100 percent of the full hydroelectric potential of the nation, each year we would save 250-300 million tons of oil alone. The economical aspect of the GES is also shown by the fact that, while producing little more than 14 percent of the electricity, they furnish nearly half the profit of the USSR Ministry of Energy. The developed capitalist nations have long understood this. In Canada, for example, 40 percent of the hydroelectric potential is being used; in the USA—45; in Japan—60; France—90; Switzerland—as high as 99 percent. And here? Only a fifth.

Nor can we ignore the fact that hydro units are ideal accompaniments to nuclear stations. The AES require continual operating duties, while the demand for electricity fluctuates at different times of the day. Thus, the hydro stations instantly take up the peak loads. For example, a nonrunning unit at the Sayan-Shushen GES requires only one minute 40 seconds to develop the rated power. Whereas TETs power generating units need almost 24 hours.

Can one reject all these facts in examining the issue of hydropower? I do not think so. Public discussion of the designs, competent straightforward criticism will of course be beneficial. But what is the reality? Already today the projects of the Turukhansk and the Middle Yenisey GES are being criticized. But does it make sense to attack projects that do not even exist yet?! It would be much more useful to discuss the issue of how to build hydro stations with the least impact on the environment. For example, society rightly demands preliminary preparation of the bed of reservoirs to prevent their pollution. On level terrain, it is possible to avoid extensive spreading of the river upstream of the dam by embankments along the shore, so that fertile land is not lost. Of course, such a hydro station is more costly, but it will still be more effective than other sources of ecologically clean electricity. There are other problems demanding widespread discussion. For example, fluctuations in the level of reservoirs, the change in the temperature conditions in the stream below a dam. But discussion does not mean rejecting the very prospect of building hydro stations out of hand. Today, unfortunately, we are witnessing a decline in the pace of growth in capacities of the hydro stations of our country. There are many reasons for this. First of all, lack of understanding of the structure of the electric power system. For example, the comparison of effectiveness of hydro and thermal stations has always been done in terms of cost within a single agency—the Ministry of Energy. But the cost of development of the fuel and transportation network, environmental protection, the need for influx of labor resources has been ignored or undervalued. As the result of such onesided approach, the building of hydro stations was slowed and many construction organizations no longer specialize in hydraulic engineering. Another factor was the reshuffling of funds for construction projects. Thus, the plan would be continuously increased in construction of the Sayan-Shushen GES as long as the project was assimilating the allocated funds. But as soon as the necessary pace was achieved, the plan would be cut back. It would appear that startup alone of the hydrounits was what everyone wanted, while the power output was of least importance. As a result, the power generating units would be brought on with the dam incomplete and the water head low, so that even now the station does not produce much power.

Such state of affairs is presently being repeated at the Kureysk, Boguchansk, Katunsk and other GES, where the plans are being overfulfilled, while limited financing persists. This means that the stations (like Sayan-Shushen) will take a long time to build—up to 25 years. Thus, consumption of oil, coal and gas will increase, and the labor resources will be used unproductively. All of this occurs because the planning of hydro units is done by a kind of leftover method. The needs of the nuclear power industry are satisfied by around 140 percent, thermal power receives 100 percent of what is needed, and the remainder goes to us.

The time has come for a genuine change in attitude toward hydro power, making it a priority once again, though not of course restricting the interests of the other

sectors. The rationale for this is the literally inexhaustible reserves of hydro power. Development of the Yenisey alone and its tributaries will produce more than 320 billion kilowatt-hours. For comparison: all hydro stations of the country at present produce 220 billion. It is easy to see that this would radically improve the energy balance of the entire country, especially Siberia.

Sharp reduction in the time frame for construction of hydro stations—to 5-7 years—is perfectly feasible today. This requires completion of the preparatory work in 2-3 years and reinstatement of a hydraulic engineering specialization. A special concern at present is the lack of hydro station designs. On this score, even if the hydro power industry were given the broadest possible clearance, we would still not be able to begin work on a single station. It takes a long time to produce a design: 30-40 institutes coordinate and ratify the designs for years on end. And the only specialized all-union institute Gidroproyekt imeni Zhuk has been loaded down with design of nuclear stations. Working in other fields, the specialists naturally lose their skills. There is yet another crucial issue, that is, involving all accessory ministries in the construction of the hydro stations, since the costs of the nonenergy requirements are constantly rising. At the Boguchansk GES, these amount to 40 percent of the overall cost of the hydro unit, at the Middle Yenisey more than half. The power industry must now create the infrastructure for other sectors as well, working out all aspects of the socioeconomic development of the regions. Of course, this slows down the development of the power industry itself, and also produces ecological problems. One of the most acute is the presence of forests in the flooding areas. The Ministry of the Forest Industry regards this as an impediment to normal operations. But until an extramural decision is made at state level, the problem will remain very acute, and the forest will continue to rot beneath the water surface or on the margin of the reservoirs.

The time has arrived to rethink the importance of hydro power in the life of the nation, and to solve the problems of its development in a comprehensive and integrated fashion.

Environment Versus Hydroelectric Needs

18610031 Moscow STROITELNAYA GAZETA in Russian 11 Sep 88 p 2

[Article by Ye. Podolskiy, senior scientist at the USSR Gosplan Committee for Study of Production Capacities and candidate of technical sciences: "A Running Start Before the 'Big Jump'" with the caption: "Major Project—Interests of the Ministry and Interests of the Nation"]

[Text] The staff of the USSR Council of Ministers, along with the Ministry of Energy, is preparing a statement on measures to hasten the development of the USSR hydro power industry in the years 1989-2000. The program for construction of a large number of big new hydro stations on an unprecedented scale is being spelled out. The draft version has already been coordinated with various departments and with the councils of ministers of the union republics.

The draft of the statement includes the clause: "The councils of ministers of the union republics, the USSR State Committee on Conservation, and the USSR Ministry of Energy will provide for discussion of the hydroelectric station construction projects with the public at large." A very interesting approach: first, a small group of executives at the Ministry of Energy, the institutes Gidroproyekt and Energosetproyekt, the USSR Gosplan, and the Office of the Fuel and Energy Complex of the USSR Council of Ministers will prepare and coordinate their plans with the collateral departments, submit them to the Council of Ministers for acceptance, and (once accepted) the public will be given an opportunity to familiarize themselves with the documents and participate in the handling of these matters as the designs of the hydro stations are being implemented (we emphasize the word designs, and not the technical-economic validating arguments). But it is clear from the outset that such discussion is too late: after all, the resolutions must be carried out! And the managers of the Ministry of Energy are aware of this. Thus, they have already (before the resolution is adopted) confidently included all these hydro stations in their plan of development of the power industry up to the year 2005, and the Gosplan has steered this through its expert panel and collegium.

Is not such attitude to public opinion hypocritical? For these plans have not yet been published, and the people know nothing of them! And this is happening after the CC CPSU and the USSR Council of Ministers adopted the resolution "Restructuring of planning and increasing the role of the Gosplan in the new economic conditions," which explicitly talks about the need to present major scientific-technical, social and ecological problems whose solution requires use of substantial economic resources to the entire nation for discussion!

Therefore, in my opinion, the draft resolution should be published immediately, and its authors should appear in print with articles substantiating the new program of hydro power construction. I can name the authors of this draft. I think it is useful to ask those responsible for preparation of the program to appear in print with a justification: deputy minister of energy S. Sadovskiy; Gidroproyekt directors L. Mikhaylov and V. Novozhenin; deputy chairman of the Gosplan A. Troitskiy with his colleagues in the department of power engineering and electrification V. Savin and L. Toropov; deputy chairmen of the Office of the Fuel and Energy Complex of the USSR Council of Ministers G. Tikhonov and Yu. Semenov; as well as the authors of the sector plan of development of the power industry, senior fellows of Energosetproyekt V. Yershevich, V. Shlimovich, A. Reznikovskiy and G. Lyalik.

But time is wasting. Therefore, let me summarize the draft resolution and make a few comments. I beg forgiveness for the technical terms and figures, but keep in mind that they stand for tens of billions of rubles, some of which (in our opinion) may be misspent, or what is more, inflict great harm on the rivers, farmlands, natural resources, and consequently ourselves. The draft resolution rightly points out the merits of hydro stations, which utilize the self-renewing hydraulic resources of the rivers and cut down on the fuel requirement of the economy, their great flexibility, and the incomparably lower labor expense in their operation.

But at the same time, we know that the hydro power construction of past decades has brought us much woe. Construction of GES cascades on the lowland rivers Volga, Kama, Dnieper, Don and others with average slopes of 5.5-7.5 cm per kilometer of length (without tributaries!), and in subsequent years construction of the hydro stations on the Angara and Yenisey resulted in inundation of a territory more than 54,000 square kilometers in area, 80 percent of which was floodplain meadows, pasture, arable land and forest. Moreover, this has brought flooding of the adjoining farmland and forest (in expert evaluations, 20-30 percent of the inundated area). Around 1.1 million people (estimate of Gidroproyekt) were resettled with minimum compensation. And no one knows how many people moved away from the farming regions near the reservoirs on account of the drastically altered living conditions. Much of the inundation of farmland occurred in the valleys of the Volga and Dnieper, the hydro stations of which presently produce no more than 3 percent of the electricity generated in the country. The condition of the water in these reservoirs is a known fact. We should have been able to foresee and make provision for this, but did not. Everything was done by directives from on high, with brash slogans. It only remained to work out the blueprints of the hydrotechnical facilities, select the turbines, and select the validating arguments. Tons of newspaper and magazine articles have already been written about this time. Not all of them are sufficiently well-founded or completely true in respect of the hydraulic construction industry itself, but they now serve as a warning to us. The draft resolution also outlines a program of new large-scale construction of hydro stations. In the next two 5- year periods, it is proposed to conclude, organize, and begin construction of 90 hydro stations with combined capacity of 115 million kW. To assess the scale of this program, we mention that the capacity of all presently operating hydro stations is 62 million kW.

Complete implementation of this ambitious program requires (by tentative estimate of the Ministry of Energy) around 80 billion rubles, of which around 50 billion will be allocated in the next 12 years (up to the year 2000). We mention that 80 billion rubles is the volume of financing of the capital construction of the entire electric power industry of the nation for two 5-year periods (at the present level).

As a result of the intensive hydrotechnical construction, the entire Yenisey (except the lower section), the entire Angara, Podkamennaya and Lower Tunguska (their lower and middle sections extend up to 1000 km) will become a stairway of dammed water-races with enormous reservoirs. The Yenisey and its major tributaries will disappear as rivers. Instead, there will be artificial lakes with a combined water surface of 24-34,000 square kilometers. In the projected GES zone of inundation, virtually all agricultural lands in these regions will be lost. It will be necessary to resettle as many as 75,000 people. Furthermore, the huge peak-load Katunsk GES is already being built in Western Siberia at the sources of the Ob. In Transbaykalia on the river Vitim, construction of the huge Moksk and Telmamsk hydro stations is planned. In Central Asia, a total of around 20 cascades and individual major GES will be built with a combined capacity of 20 million kW, of which nearly 11 million kW is to be put in service by the year 2000 (!).

Without detracting from the importance of using renewable hydropower resources in the economy of our country, I feel it is necessary to mention a number of decisive objections against the intended program. The requisite planning and technical-economic analysis has not been done, either in preparation of the aforesaid draft resolution, or the Energy Program (1984), or the sector scheme for the development of the power industry (1988). Nevertheless, all these documents have now been ratified or coordinated with all levels of government.

Most of the GES (59 of 90; 88 of 115 million kW) are to be built in Siberia, the Far East, and Central Asia. In the consolidated power systems (OES) of Siberia and Central Asia, the capacities of the presently operating electric stations exceed the maximum electricity loads by respectively 55 and 62 percent. The surplus capacity, not used in the estimated balance sheets, is in fact located at the hydro stations, and during the most critical winter months there are no water resources to provide for it. This surplus installed power of the hydro stations was built into the design to meet the peak loads during the winter low-water period and to generate seasonal power during the summer flooding. Yet the daily load schedules of these power pools do not have large peaks, while the capacities of the hydro stations are so large that they cover in winter not only the entire fluctuating load of the system, but also some of the baseline (round-the-clock) load. Due to shortage of water resources, 6-7 million kW of GES capacity in Siberia and 2.5-3.5 in Central Asia is regularly left untouched in the winter. But in the summer, due to the large specific share of hydro stations in Siberia and the reduced load, the GES cannot produce the full possible output of seasonal power during the period of flooding. This would require shutdown of nearly all thermal electric stations (TES) of the system, which is not possible.Therefore, over the course of three years (1984-1986), water has been discharged with the turbines under partial load at the hydro stations of the Siberian OES during the summer and 25.6 billion kWh has been lost, equivalent to 10 million tons of high-grade Kuznetsk coal. Such discharge with power loss is occurring to this very day at the Sayan-Shushen and the

Krasnoyarsk GES. Thus, there is a surplus of hydraulic capacity in the Siberian OES, due to increased construction of hydro stations. In both winter and summer, the units installed in these stations run on roughly 70 percent of capacity (in the winter, due to lack of water, in the summer, due to impossibility of exporting power to the system). The cost of the units needlessly installed at the GES is 300-400 million rubles.

Such a distorted situation will persist over the next two-three 5-year periods, since the peak loads will increase very slowly in the system. But if we continue to build the hydro stations in Siberia that are outlined in the draft resolution, with capacities 2.5-4 times in excess of the monthly mean guaranteed capacity (having water and pressure-head resources), then the GES capacity unused by the power system will grow by the year 2000 to 9-10, and thereafter to 15 million kW. The Boguchansk, Middle Yenisey, and Osinovsk GES in the Siberian OES will run on half capacity, the Katunsk, Turukhansk, and Podkamenno-Tungussk on a third. And this will happen throughout the foreseeable future, up to the years 2015-2020! What is the point of building such hydro stations, especially if they will use the lowland sections of the rivers and inundate all the populated valleys in the basin of the Yenisey?! A similar situation regarding use of hydro stations exists in Central Asia. Most of these operate on an irrigation regime and cannot hold back water to boost the guaranteed winter capacity. Thus, of the 8.3 million kW installed capacity, the water resources in the winter are sufficient to generate only 4 million kW at present, or 5-5.5 million kW along with the reserves. Thus, 30-40 percent of capacity is unused. Why then should we rush to build another entire armada of hydro stations in this region, the majority of which (like those currently operating) will have to run on half capacity in the winter? Thus, the gigantic Rogunsk GES (3.6 million kW), all units of which are to come on line during the next 5-year period, will figure in the balance sheets of the power system with only a fifth or a sixth of its capacity for the first five or more years during the winter!

But if we introduce another 11 million kW of hydraulic capacity in Central Asia by the year 2000, as the program envisions, then the winter-unused capacity will grow to 8 million kW, and much water will be discharged past underloaded turbines in the summer, since the overall capacity of the GES is 4-5 million kW larger than their possible load. Isn't this an absolute waste? Exaggeration of the capacities by a factor of 2-4 or even 6 as opposed to the guaranteed capacity with a view to meeting nonexistent peak loads is typical of all GES being planned in Siberia, Central Asia and the Caucasus. One should not rely on these capacities in drawing up the balance sheets, yet this is exactly what is done in the sector plan devised by the Energosetproyekt and approved by the Gosplan! The actual participation of the GES in the balance sheets will be less by a factor of 2-3 for the next several 5-year periods.

Such disinformation is highly profitable to the Ministry of Energy. Exaggerating the installed capacity of the GES by a factor of 2-3 reduces the specific cost of a kilowatt of power by the identical factor, and the promoters of unrestrained growth of hydraulic power create the impression of high efficiency among the upper level executives. Thus, if the financing of the entire program of 115 million kW of GES will take 80 billion rubles, this will cost 700 rubles per kW of power, or 560 rubles if an average of 20 percent of the expenses are allocated to development of the regions. But in reality, approximately half of the introduced units, or 57 million kW, will be able to participate in the balance sheets, even in and around the year 2015. Therefore, the cost per kW of effective capacity of the GES will now increase to 1100-1400 rubles. When this is considered, many GES are no longer able to compete with thermal or other stations, even with expensive fuel and high cost of thorough cleaning of emissions.

The authors of these projects and plans understand this and justify the construction of hydro stations in Siberia by saying that the surplus energy could be sent through long-distance ultrahigh-voltage transmission lines to the European territory of the country, a distance of 4000-6000 km. Such is the basic idea of Energosetproyekt's plan of development of the electric power system up to the year 2005. The plan which has now been approved by the GES expert panel and the collegium of the USSR Gosplan.

The feasibility of such decision cannot be examined without considering several very important points in the development of the electric power industry of our country. The Kansk-Achinsk Basin in Siberia has enormous reserves of brown coal, practically lying on the surface. This is low sulfur and low ash type. Adding this coal, the cheapest in the nation but nontransportable, to the fuel and power balance sheet of the European territory in the coming 5-year periods is only possible by means of electric transmission line. Therefore, as far back as 25 years ago, a plan was devised to construct several TES (with thorough cleaning of emissions) and long-distance high-power transmission lines. The erection of these expensive lines over a distance of 4000-5000 km can only be justified by moving large and constant (baseline) electricity surpluses. This power transmission would reduce the consumption of costly and scarce natural gas in the power systems of the European territory (down to 11 million standard tons per loop). But the implementation of this plan was aborted. Construction of TES in Siberia was halted in the mid-1960s, due to the vogue for hydro stations. The most recent TES in Siberia, the Belovsk, was 22 years old in 1987! Except for the Berezovsk station alone, no work has been done with Kansk-Achinsk coal. The construction plans in the present 5-year period are also failing. The KATEKuglestroy and KATEKenergopromstroy presently operating here are understaffed and the state of their operation is described as a "shambles."

On the other hand, the power systems of the European section of the country in recent 5-year periods have build exclusively stations able to run only near the baseline

duty, with a slight lowering of the load at night. Yet there has been no construction of highly flexible stations, urgently needed here because of the peak loads. And in this setting, instead of rushing through all necessary measures to correct the present distorted situation in the Soviet power industry, academicians A. Aleksandrov, L. Melentyev and I. Glebov have announced a proposal for a daily reversible exchange of electricity between the European territory and Siberia: from east to west in the day, from west to east in the night, through the ultrahigh-voltage transmission lines presently under construction or under plan. Such use of the lines, in their opinion, will substantially reduce the need to introduce flexible facilities in the European region and will allow a more effective utilization of the capacities of the Siberian GES, especially during the high-water periods. At the same time, this position has been adopted by one of the executives of Energosetproyekt, V. Yershevich: "We have changed the purpose of the line (the second Siberia/Central Region transmission line): it is now a maneuvering line, not a transport line. We will pump energy in both directions, pooling the energy of the nuclear plants of the European territory and that of the giant GES in Eastern Siberia into a single regulated flow."

Despite the objections of the USSR Gosstroy, the second Siberia/Central Region ultrahigh-voltage line is already under construction, even though the Kansk-Achinsk TES will not be put into operation on time. Thus, they intend to continue and intensify the flawed development strategy of our power industry: constructing as heretofore almost exclusively baseline power stations in the European region (90 percent of all those put into service), while continuing to build GES in Siberia, nearly all of which are peak or semi-peak plants, and using the high-power long-distance Siberia/European territory transmission lines in a reversible mode to organize daily transfers of around 100 million kilowatt-hours of electricity in either direction from the Urals, a distance of 4000-6000 km (from Turukhansk to the Baltic!). No less than a third of the electricity will be lost. An unprecedented case in global practice!

This "concept" is untenable in both technical-economic and strategic respects. Changing the baseline transfer of electricity into a reversible peak transfer prevents us from using the cheap but nontransportable Kansk-Achinsk coal in the most critical fuel and energy balance of the European territory and inevitably leads to increased consumption of gas, fuel oil, or long-distance transported Kuznetsk coal. In economic terms, this results in a loss of around 300 million rubles per loop (not including the cost of the transmission line itself). And this assumes that we shall use the already installed, i.e., gratuitous, but "locked-in" capacities of the presently operating GES.

But if new GES are brought on line in Siberia and transmit their peak power to the European region, the calculation should include the costs of these stations: 400-600 ruble/kW. In such case, the loss will be as high as one billion rubles per transmission line! The concept of an interdependent development of the nation's two largest energy pools is in radical conflict with the theory and the worldwide practice of creating self-balancing energy systems with power plants cited as close as possible to the centers of electricity consumption, with proportional adding of baseline and peak stations to the system.

In Siberia, it is necessary to halt construction of new GES for two-three 5- year periods and to concentrate all material and labor resources on bringing the nation's cheapest Kansk-Achinsk coals into the fuel and energy balance. With proper cleaning, such coal can be burned without detriment to the environment of the region, as proven by the 5-year projects of the institutes of four departments, headed by the MEI (Moscow Power Institute).

Thus, I do not feel that the proposed draft resolution of the government with the program of intensified construction of GES can be approved. There should be public debate of the GES projects before, and not after the issuing of a resolution. The latter is especially important, because the proponents of unrestrained expansion of hydraulic power construction are using improper procedures, exaggerating the effectiveness of GES or committing mistakes due to the disinformation being furnished them. For many years now, this disinformation has been permeating all scientific, design, and planning documentation. To the foregoing might be added that there has long existed a practice of promoting members of the Ministry of Energy (and Gidroproyekt itself) to the central administrative offices, who are ardent proponents of hydraulic power construction but sometimes have little understanding of energy economic analysis, much less the natural sciences. A definite expansion of the department is underway. But we can no longer destroy our country and ruin its resources by carrying out venturesome projects on behalf of the people.

How to Estimate Additional Costs Incurred by Switching Thermoelectric Power Plants in Operation to Non-Design Fuel

18610146 Alma Ata VESTNIK AKADEMII NAUK KAZAKHSKOY SSR in Russian No 1, Jan 88, pp 25-31

[Article under the "New Ideas, New Investigations" rubric by E. E. Loyter and O. Nadirbekov]

[Text] As we know, the primary trend in the fuel supply of the power industry at present is a transition to the use of fuels of ever lower quality. The reasons: depletion of easily-accessible, high-quality energy resources, conversion to high-output technology which is ill-suited to selective mining, and, lastly and most important, husbanding of resources, i. e., bringing low-calorie fuels into the economic cycle which, for the present, can only be used effectively by the power industry. This tendency produces the greatest difficulties in regard to the fuel

supply of existing TES [thermoelectric power stations] when required to convert them to the burning of fuel with lower quality characteristics.

We shall not dwell on whether or not it is advantageous in general to convert existing TES to fuel with worse characteristics. This is, evidently, a technical and technical-economic matter, the answer requiring a knowledge, first, of the possibility of a (technical) conversion of the TES to the burning of a different fuel (hereafter we shall call this "non-design" fuel) and, second, what this would cost. If such conversion is possible, then technical-economic calculations should reveal the feasibility of reconstruction of each existing TES burning the given fuel, the optimal sequence of their conversion to the new fuel, and so on.

Quite understandably, it would be illogical during the phase of technical-economic validation to work up specific, detailed reconstruction plans for many power stations, simply to assess the feasibility of their conversion to a new fuel. Thus, there can be no doubt as to the importance and urgency of a general scheme for assessing the additional costs incurred in the conversion of existing TES to a non-design fuel.

In this large and multifaceted problem, the present article considers only the question as to the conversion of power stations to fuel with elevated ash content. Such procedure is imminent for the existing TES of Northern and Central Kazakhstan, the Southern Urals, and Western Siberia, in connection with the conversion to large-scale extraction of Ekibastuz coal, as a result of which the average ash content may increase from 40-42 percent to 55 or even 60 percent.

Although quite a few works [1, 2] have been devoted to the subject of increasing the ash content of coal supplied to existing TES, virtually all of them are based on the same methodological assumptions, namely, the operation of existing TES on fuel with elevated ash content is treated as an extraordinary event and, therefore, the main goal of the investigation comes down to calculating the loss associated with this.

It is easy to show that, for the situation when an existing TES is converted to permanent operation with fuel of elevated ash content, the traditional approach with calculation of the loss from using an "unconditioned" (high-ash) fuel is absolutely unproductive. Obviously, only an approach in which all changes in the working conditions of the power generating equipment produce no interruption in the continuous and full-value supply of power to the customers may be considered logically founded and productive. Such approach, moreover, is also systematic (integrated), since the problem of preserving an uninterrupted power supply to the customers cannot be solved in isolation from the power system (and, in the most general case, in isolation from the power supply conglomerate).

Thus, the problem in question can be formulated as follows: the parameters of a certain TES, operating within an electric power system (EES), are given. The station was designed to operate on fuel with ash content A_1^c (hereafter the index "c" is omitted). It is planned to convert this TES to an identical fuel, but with ash content A_2A_1. What are the minimum necessary additional costs to the EES in maintaining an uninterrupted power supply to the customers? At the present, initial stage, we introduce the following constraint: we shall consider only the conversion of a KES [condensation electric power plant] to fuel of elevated ash content.

The first and critical problem is, obviously, the technical possibility of the KES operating on fuel with elevated ash content. As has been shown in [2], even a substantial rise in ash content of coal (say, Ekibastuz coal) does not require major reoutfitting of the existing boilers, and in theory their original steam output (i. e., corresponding to the designed type of fuel) can be achieved. However, direct conversion of a KES to fuel with elevated ash content causes a substantial loss in energy efficiency. This is the consequence primarily of the inadequate efficiency of the fuel preparation departments, since there is less combustible matter contained in the previous volume of the natural fuel, due to the increase in ash content.

It should be emphasized that, even in the case of redesign of a KES (but without redoing the electrical section), the former energy efficiency cannot be maintained, due to the inevitable increase in consumption of electricity for internal needs of the power station.

Thus, conversion of an existing KES to high-ash fuel can be done in various ways, starting with the alternative requiring minimal additional capital investment (i. e., virtually no major redesign), but with considerable loss of energy efficiency[1], and ending with the alternative of major redesign of the station, while as much as possible keeping the parameters as they were before.

Evidently, the most that can be achieved by redesign is to retain the former steam output of the boilers. With this, we obtain both maximum utilization of the existing primary assets and (in particular) a 100 percent utilization of the electrical section, which will not obtain in the other alternatives (with lower energy efficiency). Therefore, it is quite logical to take this conversion alternative as the baseline, since all the others will be cheaper (in terms of additional capital investment), but will require larger expenses from the EES on measures to offset the decrease in energy efficiency of the KES in question. Consequently, the new formulation of the problem might appear as: there is a KES operating on fuel with ash content A_1. It is converted to an identical fuel, but with elevated ash content A_2 A_1. What minimal additional expenses are necessary for uninterrupted power supply of the customers, provided that the steam output of the boiler assemblies after the redesign of the KES is the same as it was when using the former fuel?

As already mentioned, the additional costs consist of two main components: a) costs on redesign of the KES and b) costs in the EES on offsetting measures to make up for the inevitable decline in energy efficiency of the power station being redesigned. Apart from the increased outlay itself, the decline in energy efficiency also comes from more frequent shutdown of the station for scheduled maintenance and a possible increase in the malfunction rate. In the present article, the main emphasis is placed on problem a). It may be noted that problem b) has already found a partial treatment in [4], specifically: the "systematic" component of the additional costs incurred by the increased internal expenditure has been estimated.

Let us briefly characterize the nature of the KES redesign needed to maintain the former steam output of the boilers. If we assume that no radical redesign of the steam generator itself is required (although, without doubt, measures will be necessary to deal with the increased local wear and tear on the boiler surfaces), the redesign should affect three elements of the station: the fuel preparation, the efficiency of which should be increased; the ash removal system, the efficiency of which should also be increased; and the ash trapping system, where increased efficiency is required.

Let us examine the possible ways of estimating the additional costs associated with these modifications.

Obviously, the estimation of the additional costs on redesign of the KES should start with systematization of their parameters. Since we are dealing with existing power stations (including the "veterans", plants which have operated 50 years or more already), clearly there is an enormous variety of equipment types and different combinations. In order to identify whatever general mechanisms exist in the variation of the additional costs, we can use the approach of creating a "model" power station. The essence of this comes down to the following: we shall assume that the parameters of the initial "design" fuel (with ash content A_1), the steam output of the boiler assemblies and their total number, or the nominal capacity of the KES, are given. Evidently, guided by the prevailing design norms and selecting any one that is suitable (in the present case, the most sophisticated modular configuration), we can "design" a KES operating on this fuel. Then, "redesigning" this same KES to operate on the non-design fuel (with ash content A_2A_1), we can estimate the additional capital investment needed for the redesign. This approach lets us vary in wide limits both the parameters of the fuel (i. e., A_1 and A_2) and the parameters of the KES (number of power generating units, their specifications, etc.). Furthermore, there is no need to examine those elements of the KES which do not need redesign (e. g., the electrical section). Of course, there are also certain drawbacks, namely, we cannot include all the "nuances" of a real-world KES. Consequently, the estimation of the additional costs on redesign of the station will be done with a certain inexactitude, which is inevitable in a generalization.

Let us consider the application of the method to the example of redesign of the fuel preparation department. Obviously, for given specifications of the power generating units, and the initial fuel with ash content A_1, we may compute the necessary parameters and number of coal crushing mills. Let us assume that n_1 are required [5]. Conversion of the power station to fuel with ash content A_2 requires a larger hourly expenditure of pulverized coal in order to offset the reduced volume of combustible matter (per unit of natural fuel), as well as the reduced boiler efficiency, and maintain the former steam output. Clearly, the productivity of the fuel preparation department can be improved in various ways: by installing additional mills, by replacing all mills with more efficient ones, and so on. Certainly, in each specific instance, the most applicable and least expensive alternative will be selected for the redesign plan of the particular KES. However, for a generalized estimate, it is easier and more logical (and also perfectly acceptable from the standpoint of engineering) to add a certain number of mills of the same type as already installed in order to boost their overall capacity.

Say that n_2 mills are required to grind the new outlay of natural fuel. Since the type of mill has already been chosen, it is not hard to determine (from the available price lists [6-9]) the additional cost for introduction of $n_2 - n_1$ mills, taking into account their installation and a certain expansion of the building.

A similar approach could also be used to evaluate the additional costs on increasing the throughput capacity of hydraulic ash removal (GZU). But here, there is a complication in that, besides increasing the number of streams of pulp feed lines, it is also possible to increase the throughput capacity of the already present pulp feed lines by increasing the speed of the pulp. This can be achieved by increasing the output of the dredging pumps. This alternative is cheaper than constructing additional streams of pulp feed lines (in terms of capital investment), but the increased speed of the pulp produces a sharp rise in the wear on the pulp feed lines and, thus, shortens their service life. Thus, the proper solution (i. e., that requiring minimum additional costs to increase the capacity of hydraulic ash removal) can be found only by optimization (comparing different alternatives), with allowance for the time factor.

A somewhat different approach is needed to evaluate the additional expenses on the ash and cinder dumps (ZShO). Evidently, conversion of the KES to a fuel with ash content A_2A_1 will more quickly fill the dumps, compared to operation of the station with the designed fuel. This means that the readying of new areas for the successive stages of the dumps must be done in advance, and consequently resources must be allocated for this. Thus, the shift in time of the costs is indeed an economic loss from the higher ash content of the fuel in terms of the ash and cinder dumps. It is not difficult to show that the important factor here is the degree of filling of the dumps at the instant of the conversion of the KES to

non-design fuel. If, at this time, the filling is near 100 percent, the economic losses will be minimal, since new area would have had to be acquired in any case. But if the filling is much less than that, then the losses are a maximum, since the ZShO will be filled much earlier than in the starting alternative.

Estimation of the additional costs for ash cleaning requires a fundamentally different approach. Here, unlike the fuel preparation or the hydraulic ash removal, a linear rise in capacity of the ash collection equipment is not possible, especially since the search for the most rational technical solutions for an effective collection of ash from fuels such as Ekibastuz coal is still under way.

First of all, we shall formulate the primary postulates for such an estimate: a) we shall concern ourselves only with use of already commercially developed equipment—cyclone banks, Venturi pipes, electric filters, for which there is operating experience available and which are series manufactured by industry; b) we shall start from the condition that conversion of the power station to the burning of high-ash fuel not impair the ecological surroundings, i. e., the overall volume of emissions must remain at the former level.

If we know the volume of emissions of the KES using the designed fuel (which is obviously determined by the ash content of the fuel, the steam output of the boiler assemblies, and the efficiency of the ash collection equipment), then it is easy to calculate the new, elevated efficiency that must be achieved in order to maintain the former volume of emissions, despite the increased volume of ash in the flue gases. Since direct engineering analysis of the redesigned ash collection is difficult, an attempt has been made to study the trend of ash collector (ZU) cost variation as a function of a number of parameters: the steam output of the boiler assemblies, the ash content of the fuel (of specific given type), and the efficiency of the ash collectors. Statistics have been gathered for all boiler assemblies that have ever used or are still using a given fuel with various ash collecting equipment having different efficiencies for different ash content of fuel. Regression correlation processing of these statistics led to a multivariate, nonlinear regression equation, by means of which it is possible to estimate the anticipated increase in ash collection costs by changing one of the control variables. In some cases, of course, extrapolation of the observed trends in the cost variation of ash collectors will be appropriate.

The main attention in the present work has been devoted to a mere outline of the basic ideas (principles) underlying a system of economic-mathematical models which has been worked out.

The system consists of 4 blocks, each of which is formulated as a corresponding computer program[2]. The first block estimates the additional costs on redesign of the fuel preparation (including the unloading equipment, the fuel stockpile, etc.), the second block computes the minimal necessary additional expenses of redesign of the hydraulic ash disposal, the third the increase in costs of the ash and cinder dumps, and the fourth the anticipated increase in costs on ash cleaning [of gases]. All the numerical (quantitative) indexes for a given specific set of programs have been taken from the specifications of KES running on Ekibastuz coal[3]. The range of allowable variation in the starting data is as follows: KES capacity, 100-3000 MW; boiler capacity, 50-950 T steam per hour; ash content of Ekibastuz coal, 42-60 percent.

KES Elements	Parameters and Indexes	Model Station	Redesign	Additional Expenses, millions of rubles
	Ekibastuz coal ash content, percent	42	58	
	Specific outlay of natural fuel, kg/kWh	0.58	0.88	
	Area of fuel stockpile, ha	2.15	3.25	
Fuel Transportation Section	Number of workers at the car dumping and unloading equipment, individuals	1.0	2.0	4.813
	Number of workers at the fuel supply points, individuals	1.0	2.0	
	Number of crushing mills, units	45.0	75.0	
Hydro ash disposal	Number of workers at the pulp feed streams, individuals	1.0	3.0	
	Number of workers at the dredging pumps, individuals	1.0	3.0	1.333
Ash and cinder dumps	Degree of fill, percent	70.0	-	3.754
	Time it takes to fill, years	14	6	
Ash collection	Overall ash emission, kg/s	6126.6	6126.6	1.040
	Efficiency of ash collection, percent	90.0	95.6	
				Total: 10.940

To illustrate the capabilities of the program system, we give the following specific example: say we have a KES with rated capacity of 700 MW, outfitted with 15 boilers having steam output of 220 T steam per hour, efficiency of dust collectors 90 percent, degree of filling of ash and cinder dumps 70 percent. The KES is running on Ekibastuz coal with mean ash content 42 percent. It is necessary to convert this power station to burn identical Ekibastuz coal, but with mean ash content 58 percent. What additional costs are needed to maintain the steam output of the boiler assemblies at the former level under the new conditions? The basic results are summarized in the table.

The figure [omitted] shows the relationship between the additional costs needed for redesign of the particular KES and the ash content of Ekibastuz coal. As is readily apparent, the curve is distinctly nonlinear, i. e., for each percentage point of increase in ash content increasingly more additional expenses on redesign of the power station are needed.

It would seem that the first priority of future investigations should be a generalized estimation of additional costs incurred by the possible redesign of thermoelectric centrals and boiler heating plants. This is because of the large numbers of TETs and boiler plants and the diversity of their parameters.

Footnotes

1. Thus, conversion of a power station running on Ekibastuz coal with ash content up to 40 percent to the identical coal but with mean ash content up to 55 percent entails a 30-40 percent lowering of energy yield.

2. The computer programs were written in FORTRAN by engineer E. A. Nedelchik.

3. To solve the analogous problem for other regions of the country, i. e., other fuels, it is necessary to alter the number files entered into the programs.

Bibliography

1. Mansurov, V. I., Degtev, O. N., Vdovchenko, V. S., "The Change in Quality of Ekibastuz Coal and the Losses from Its Deteriorating Quality" in the book "Nadezhnost i ekonomichnost raboty kotelnogo oborudovaniya pri szhiganii ekibastuzskikh ugley" [Reliability and Operating Economy of Boiler Equipment Burning Ekibastuz Coals], Chelyabinsk, 1985, pp 3-12.

2. Gorshkov, A. S., "The Economic Loss From Deteriorating Quality of Power Industry Coal and the Effectiveness of Dressing", ELEKTRICHESKIYE STANTSII, No 9, 1983, pp 2-4.

3. Aliyarov, B. K., Zhabagin, A. A., Ustimenko, B. P., "Burning of Ekibastuz Coal of Elevated Ash Content in the Firebox of the Boiler PK-39 of 300 MW Power Blocks of the Yermakov GRES", TEPLOENERGETIKA, No 4, 1986, pp 11-15.

4. Nadirbekov, O., Tashenev, S. Zh., "An Economic-Mathematical Model of Costs of Adaptation of an EES to Changing Conditions of Fuel Supply" in the book "Model dlya prognozirovaniya razvitiya energosistem" [A Model for Forecasting the Development of Power Systems], Moscow, 1980, pp 53-63.

5. "Raschet i proyektirovaniye pyleprigotovitelnykh ustanovok kotelnykh agregatov (normativnyye materialy)" [Analysis and Design of the Pulverized Coal Preparation Equipment of Boiler Installations (Normative Materials)], Leningrad, 1971, 309 pp.

6. "Preyskurant No. 22—02. Optovyye tseny na oborudovaniye drobilno-razmolnoye" [Price list No. 22-02, Wholesale Prices for Crushing and Grinding Equipment], Moscow, 1971, 103 pp.

7. "Preyskurant No. 15—02. Optovyye tseny na mashiny elektricheskiye bolshoy moshchnosti, turbogeneratory, gidrogeneratory i kompensatory sinkhronnyye" [Price List No. 15—02. Wholesale Prices for High Power Electrical Machines, Turbogenerators, Hydrogenerators and Synchronous Compensators], Moscow, 1980, 143 pp.

8. "Preyskurant No. 15—01. Optovyye tseny na mashiny elektricheskiye sredney i maloy moshchnosti" [Price List No. 15—01. Wholesale Prices for Medium and Low Power Electrical Machines], Moscow, 1967, 237 pp.

9. "Tsennik na montazh oborudovaniya No. 6. Teplosilovoye oborudovaniye" [Price List for Installation of Equipment No. 6. Thermal Power Equipment], 1971, 80 pp.

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Kamenev on Formula for 'Turning Point' in Machine Building

18610030 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 23 Sep 88 p 2

[Article by A. Kamenev, doctor of technical sciences, first deputy chairman of the USSR Council of Ministers Bureau of Machine Building]

[Text] It is hardly necessary to convince anyone of the enormous importance of the machine industry today in restructuring the economy. This is the heart of the scientific and technical progress of the entire economy, and therefore the foundation for better effectiveness. The decisions for modernization of this key complex which were developed after the April (1985) plenary session of the Central Committee of the CPSU and clarified at the June (1986) plenary session have assumed the aspect of a national program and become an organic element in the conceptualization of socioeconomic progress.

In the present five year period, the machine industry is to achieve a production growth pace 1.7 times greater than the industry-wide average. Even more difficult is a second goal, unequaled in both Soviet and Western practice: to attain the worldwide level in parameters of basic product types within a specified time. It will be necessary to increase the productivity and reliability of the machines by a factor of 1.5-2, and reduce the time for development and assimilation of new machines by a factor of 3-4. Accordingly, the machine industry has been granted the necessary priorities in capital and resources. The first half of the five year period is over. Analyzing the results, we may note substantial progress. Output of products was as large as the three and a half years of the previous period. The goals of product renewal and compliance of the most important product types with the worldwide achievements have been exceeded, even though experience shows that in no way have all problems of evaluation of the technical level been solved. The methodology is based on self-appraisal criteria, which are far from objective. However, for the first time a unitary approach has been worked out here, which is of major importance. More than 5000 machines, items of equipment, and instruments, most of them purchased by import from the capitalist countries, have been assimilated. We are holding to the course of a prioritized development of the complex and its basic sectors—especially electrical engineering and instrumentation—compared to the rest of the industry. Twice as many resources have been added to the research and experimentation base as the entire previous five year period.

Thus, no small effort has been made, and the achieved results are greater than at any other time. Even so, the turning point in the machine industry has not yet been reached. More than one and a half billion rubles of product fell short of the goals of the five year period. The demand of the majority of sectors of the economy for needed machinery is still not satisfied. And no matter how captivating the desire to think that the turning point is on the verge of happening in the near future, the actual situation provides no grounds for such conclusion. Nevertheless, this conclusion itself comes under the heading of perestroyka. Especially since it is not drawn at the end of the five year period, as was formerly the case, when nothing could be changed and all that remained was to affirm the fact. And the main point, without doubt, is how it is framed, the understanding of the need for new approaches to modernization and expansion of the machine industry.

Briefly put, the new approaches can be expressed in the seemingly paradoxical phrase: In order to lift the machine industry drastically, we must first of all foreswear any attempt to develop the entire industry at once. There are not enough resources for this. The experience of the two and a half years of the five year period convincingly supports this. One should take due note of the breakthrough areas, concentrate the assault forces on them, form a breech, and then draw up the remaining units. Thus, it is a question of decisive restructuring of the structural organization and investment policy within the machine building complex. And the burning issue here is surely the choice of economic priorities. Of course, priorities have been assigned in the past. But how? The ministries and departments, along with the central economic bodies, would formulate their goals for the future, adapting their needs to them. Programs would be worked out and assignments specified, but without regard for the actual potential of the machine industry or coordination with its development plans and investments. These were basically departmental priorities, artificially given the status of economic priorities. The shortcomings of such practice are many, chief of which is the failure to comply with the actual possibilities.

The overall volume of the machine industry assignments was 2-3 times greater than their production potential. The developers of such programs thought that the more items "crammed" into the resolutions and assignments, the better they would be supplied with equipment. But in reality, they only strengthened the dictatorship of the producer. With an obviously impossible volume of orders to fill, the producer was able to choose that which was profitable to himself, and not the consumer.

Such was the situation at the outset of the five year period. Given the accelerated renewal of products and the drastically rising demands on product quality, the situation became acute, at times dramatic. Many of the assignments for development of new machinery were distorted, and then thrown out. The time, manpower, and resources were wasted. Reality urged an intervention in these processes. But it was not just a question of bringing the assignments of the machine industry in correspondence with its capabilities; at the same time, it was necessary to concentrate the resources on truly revolutionary areas, which could in short order assure a

thorough-going modernization of the economic complexes and at the same time provide the machine industry with everything needed to accomplish its goals.

Today, we may say, the machine industry, along with the consumers, the USSR Gosplan, and the State Committee of Science and Technology (GKNT) have accomplished such a task. Forty-four priority areas have been formulated.

In the area of social development, four directions have been selected, including consumer goods of high quality and functional capabilities, modern medical equipment, publishing and polygraph equipment. There are eight priorities working on the Food Program. These include complexes of automated equipment for processing food products, furnishings for silos and animal farms, special machines for work team and leasing contracts and for individual farmers, and new machinery for progressive technologies. Twelve areas encompass the most important transportation goals. First and foremost is passenger transit. There are railroad cars with improved comfort, modern subway and suburban electric train cars, a new generation of municipal and intercity high-capacity buses, and passenger cars of compact class. There are six priorities in the construction sector. First and foremost is machinery for fundamentally new technological processes, including the erection of individual homes and buildings, machines for laying new roads, repair and upkeep thereof. There are three priority areas each in the fuel and energy, the metallurgy, and the mechanical engineering complexes, and five in the wood chemistry complex.

The accelerated development of the machine industry, of course, is also an urgent priority, the purpose being to create the scientific and industrial potential for best possible satisfaction of the domestic demand for machinery with excellent consumer qualities and solve the problems of competitiveness of machines, equipment, and instruments on the foreign market. We should point out that six areas will organize research and development of machinery that is of general importance to the national economy—mechanization of heavy and dangerous work, computerization of engineering and managerial work, equipment for energy and resource-sparing technologies, electronics, and software development. Even such a short list provides an understanding of yet another major factor that has governed the formation of the priorities—their specific orientation to the human interests and meeting of human needs.

Finally, the factor of time is not only decisive, but also very rigorous. In the years remaining till the end of the five year period, it is necessary to achieve the maximum possible acceleration, in order to reach the necessary levels of production for the sectors consuming machinery, equipment, and other appliances in the following period. In 1988-1990 alone, it is necessary to carry out more than a thousand development projects and pilot industrial prototypes. For this, more than half the scientific-technical potential of the machine industry and investments toward development of the experimental and scientific research base, reconstruction and retooling of the enterprises, and almost three-quarters of the computer technology and other means of automation of scientific and engineering work allocated to the machine industry will be assembled in the priority areas.

Similar large-scale measures are envisioned in the adjoining sectors which develop and supply the machine industry with complementary parts, materials, and means of automation. A special place will be given to the construction complex, carrying out the implementation of the required investment policies in the machine industry. The topics of changing the structural policy and the determination of priority areas in the machine industry have been discussed and approved by a conference at the Central Committee of the CPSU. The "summary program for implementing priority areas of creation of new generations of machinery for extensive modernization of the economic complexes in the years 1989-1995" is just now being completed. This will be ratified in October and will become the single document for all levels of management and implementation, combining the interests of the state with the economic motivation of the labor groupings, and will encourage their maximum contribution to the end result. 140 assignments in development and supply of fundamentally new kinds of machinery, encompassing 41 priority areas, have already been included in the government order when the State Plan of Economic Social Development of the USSR up to the Year 1989 was being drafted.

Formation of the priority areas and development of measures for their implementation enabled a more judicious determination of the areas of restructuring of the applied science. By the end of the five year period, there should be a nearly threefold increase in volume of research and development, the share of capital investments allocated to development of the experimentation base should be brought up to 15 percent of the total volume, and the engineering capital-labor ratio should increase several fold.

The primary resources for these purposes have been earmarked. The authorities have decided to form major financial reserves and economic incentive funds for development of especially effective technology in the breakthrough areas. Engineering centers and cooperatives are being formed, and contests are being held. Already today the USSR Council of Ministers Bureau on the Machine Industry is providing material and organizational support for the initiatives of the work force and individual specialists that have proven their creative talent in practice. The bureau's All-Union Research Institute of Machine Building Problems operates as the main analytical center for incoming proposals. And they are glad to receive them.

Of course, we realize that this is merely the first step, an approach to the restructuring of the science in the sector. The many stereotypes in organization of the activities of

the research institutes and design bureaus, the many years and now habitual undervaluation of the work of the engineer have grown into strategically dangerous situations and become a curb on scientific-technical progress, requiring radical and deep-going measures. It is no secret that many once progressive design schools have lost their standing and the share of original projects is drastically reduced. In their place have come imitation and mediocrity and the bureaucracy is flourishing. As a result, the applied science in the machine industry has become the most neglected area, least able to meet the demands placed on it. By today's standards, half the research institutes and design offices are ineffective, with low turnout, and it takes years for their projects to come into production. At the start of the five year period, the volume of research and design work amounted to little more than two percent of the volume of goods produced, which is substantially lower than that in worldwide practice. The capital-labor ratio of the institutes and design offices is also several times lower than the worldwide level; roughly 40 percent of these organizations have no experimental testing base. The ministries have in fact resigned themselves to the present situation. The emphasis of their labors, and even the attention of the scientific-technical public and the mass media, has gradually shifted to a mere appraisal of past achievements. To be sure, supervision of the implementation of the current assignments is an important matter, but comes in second place. The first priority is the constructive plan, and this has remained in the background for many years. The radical, fundamental conditions which would allow development of highly effective technology are of a multisector nature. At the same time, the presently accepted "technology" of creation of new products is artificially forced into the rigid framework of the individual ministry. And this is no accident.The ministries reflect the historical narrow-bureaucratic principle of management with characteristic features of economic isolation. On the one hand, this has been fostered by the many years of autonomous development of the machine industry as a whole, which received capital, material and moral incentives with no economic reliance on the consumers or the marketplace. On the other hand, this comes from the autonomous development and economic isolation of the sectors within the machine industry itself. These factors caused and continue to cause lack of communication and redundancy in the scientific-technical policy, reducing the technological specialization, cooperation, and other interdepartmental relations.

The nature of the departmental and economic isolation is ingrained in applied science as well. Two or three decades ago, when the production of the machine industry was not so complicated, it was still possible to work around the autonomy of the sectors. But the objective laws of development of engineering have led to a high integration of the achievements of many areas of science and production, which can no longer be managed in the framework of a single sector. Shortcomings in management and low rate of production of applied science, imposed on such factors as scarcity of electronic equipment, high-quality structural materials, and complementary parts—this is the objective environment which is greatly hampering the inventors of high-quality machinery and prevents us from realizing even that potential which is available.

In worldwide practice, complementary parts and highly effective structural materials are an object of special concern. They are rapidly upgraded, produced in surplus, and form the foundation in assuring a high technical level and reliability of the products. The situation in regard to electronics is especially grave. Today, when automation is being accomplished by means of integrated microcircuits, the processes of creation of the means of control and the machines themselves have become inseparable. They should go hand in hand, in coordination. But in practice, the development of machines, automation, and built-in electric actuators is distributed among the sectors. This historical baggage has become a major obstacle today in the creation of modern machining centers, robots, transportation equipment, and many other kinds of machines. Thus, the forms of organization of applied science that have taken root in past decades and the relationship between science and production and the contractor prevent the application of modern ideas in solving the problems of scientific-technical progress. Thus, we may not anticipate a radical turning point, either in the pace of creating new machine products, nor in their stature. Serious structural and organizational changes are necessary to remove this conflict. First of all, the decision making in regard to development and production of highly effective complementary parts, measurement appliances and general mechanical engineering equipment, structural materials, and special electronic componentry must be moved to the government level. All scientific organizations, design offices, and machine producing enterprises engaged in creation of such products and materials should operate in a new economic environment on behalf of the entire machine building complex and in the framework of a single organizational system. It will probably be expedient to group them by common theme of research and development, avoiding duplication and parallelism. Such is the layout of the restructuring that is coming upon us. But we also need a concrete form, incorporating the new principles into daily life. In this connection, the proposal of a number of leading scientists of the nation regarding formation of a USSR Academy of Engineering is apt and deserves thorough study. This would not be just another administrative or scientific superstructure, but a unique body, taking upon itself the practical solution of general engineering problems. This should be, first and foremost, an academy of projects. Beginning with mechanical engineering, its activities should gradually encompass the other spheres of the national economy. There does not appear to be any need to support the engineering academy with state funds. The financing of its operations could be done on the basis of economic contracts, both in the form of a government order from central resources and in the form of direct contacts with the consumers of the scientific and technical products in the industrial sphere. There is every reason to expect

high economic profitability from the academy, since it will bring together the best engineering minds and talents, major research laboratories, and the requisite production potential in a harmonious combination. The academy would in fact become a "brain trust" of scientific-technical progress in the machine industry, bringing to life the high goals of radical economic reform, social and democratic transformation of our society. Structurally, it would be advisable to supplement such a center with a group of intersector state-run associations, consortiums, and associations of scientific-technical organizations engaged in development and industrial production of the full array of complementary parts of general machine building applications, as well as especially important types of new generations of machine product of nationwide significance. Naturally fitting into this structure and finally coming into existence would be an institute of general designers responsible for development of the most important scientific-technical directions in the machine industry.

The USSR Council of Ministers Bureau on the Machine Industry is also working out other promising proposals and measures with the central economic offices. The purpose of the restructuring of applied science in the machine building complex thus comes down to solving two major problems: its structure should correspond to the modern technology of creation of new machine products, and it should be manageable, allowing implementation of an active scientific-technical policy. The main goal of such organization is that all its elements should be linked by mutual interests, yet at the same time independent. Each subdivision should concentrate on specific consumers, responsible for its economic welfare. It is this which guarantees the viability of the system and allows it to evolve.

At the same time, and no less important, it is open to external influence. Through such instruments as the investment policy and government orders, the state can bring together major material and financial resources and specialist manpower in critical areas, supporting breakthroughs in engineering and technology. Since all the elements of the complex are linked together, these achievements are quickly assimilated and become the joint property of all. Thus, development occurs in spurts, which worldwide practice shows to be the most progressive.

In conclusion, I feel it necessary to answer the question that has doubtlessly suggested itself to the reader. It is troubling the labor force of those institutes, design offices, and enterprises not part of the 44 priorities. These, we must admit, are confronted with difficult times—everyone understands that the concentration of manpower and resources in critical areas will take precedence over the others. What can be said on this score? There can be no general recommendations, of course. In each individual instance, it is necessary to start with the particular facts and features. But the basic tendency is to develop individual tactics and strategy of economic well-being, predicated on the interests of the consumer.

First of all, the principle of earning and living on one's earnings must be pursued with deeds, not words. When the designers of the Minselkhozmash for years on end developed a system of machines in an assortment of more than 2000 items—not knowing which of them was urgently needed today, and which were needed the day after tomorrow (which means they would receive no remuneration tomorrow)—they were in effect living on credit, since the state was supporting them. Today, we and the contractors have analyzed their imminent requirements and our goods on hand and selected 150 machines that in fact handle the major problems in agriculture. The developers of these machines will receive the utmost possible so that these products will appear in the fields and on the farms in sufficient numbers at the earliest date.

Such restructuring complies with the major demand of the present orientation to the consumer. The methods of controlling this complex process are also suitable to the times. They are based on a combination of strong centralized measures to solve the key problems with widespread development of economic independence and democratization of all areas of activity of the labor force.

And what about the ministries in such situation? Increasingly, one hears voices calling for abolition of these management bodies, saying that they have used up their capabilities in the new economic conditions. However, such changes would likely sacrifice the positive experience that has been built up by our routine management. In the machine industry, new forms of activity are developing in the form of the lease and the cooperative. The process of forming interdepartmental state-run associations engaged in production of like products with an explicitly stated customer is on the rise. All of this will inevitably reduce the number of enterprises and associations making up certain ministries.

But in the machine industry, the product mix of consumer articles such as motor vehicles, tractors, items in electrical engineering, instrumentation, and the like, is huge. These are produced in large volume and require an efficient coordination of the work that is needed by all, without a specific customer. It is not possible to abandon the sector management bodies here. At least, not for a considerable time. But certainly, these should be democratized management bodies, representing the interests of consolidated sectors operating on economic principles and responsible for formulating a future scientific-technical, structural and investment policy on behalf of a well-proportioned and deliberate development of designated areas in the economy. The process of restructuring is necessary in the area of management of the machine industry, but the methods should be well-gaged. And it would be inconceivable not to rely on the positive experience of the many years of work of the sector ministries.

The dynamism, complexity, and ambiguity of the processes occurring in the economy since April have convincingly demonstrated that the Party's evaluation of the

special role of the machine industry as a powerful lever of intensification of the economy and realization of the first-priority social goals is accurate and well thought out. The problems of science, industry, and management are concentrated here with special urgency. The machine industry has become a test ground for innovations in radical economic reform. The problems of organizational restructuring make their earliest appearance in this economic complex. And success will depend primarily on active and motivated participation of every group, every individual worker of the machine industry in this process. We must awaken talent, attune it to a breakthrough, take the advice of the production engineers and the scientific-technical public on critically important aspects of development of the machine industry, yet not drag out the discussions, but instead boldly begin practical verification of the developed strategies. And not be afraid of their innovativeness or diversity. The products of the machine industry in the shortest possible time must fully meet the needs of the country and occupy a worthy place on the world market. There is no alternative here.

Data Bank for Automation, Robotics in Operation

18610171 Moscow NTR in Russian No 3, 2-15 Feb 88 p 2

[Article by A. Sherstogatov: "Terminal Network"; first paragraph is NTR introduction]

[Text] At the end of last year, an interdepartmental commission accepted for experimental commercial operation a data bank for flexible manufacturing systems and robotics products for sectors of the national economy. It was developed at the All-Union Scientific Research Institute of Information and Technical and Economic Research on Machine Building and Robotics (VNIITEMR), which is responsible for database organization and management for the machine tool building industry.

Designers know that designing is preceded directly by the process of orienting oneself in a sea of information: one needs to find analogs in order not to reinvent the wheel, to assess the level of one's own development in relation to them, to examine options for improving the design, etc., etc. The job is titanic if one takes into account the fact that just any single technical trend is accompanied by the issuance of a few hundred journals in the world. About 700 periodicals elucidate questions relating to machine tool building, for example.

Under the "auspices" of an associate of the institute, I start punching the keys on a personal computer. The task has been assigned.

Designs similar to the one conceived from around the world are arranged in a vertical column on the screen in a few seconds. Having examined the list offered, we select one or two of the most suitable models. The computer, catering to our interest, delivers up the maximum of what it knows about each one. Displeased with one specification, we turn to the computer with the request to look for a model of a robot having the required parameter. In an instant exhaustive information appears on the screen (load-lifting capacity, moving speed, overall size, etc., down to a graphic representation of the design offered).

This system, now in service, makes it possible to sort out the information needed for designing and to "weigh" it; e.g., to try to find out which firms produce the product of interest, how much it costs, what else this firm produces, and which organizations in our country have similar developments under way. It assists in assessing features of interest and in choosing the optimal one from them, and finally, having assigned its own parameters, in producing those missing, i.e., in constructing a model of the future product.

"A distinctive feature of the information system developed at the institute," relates VNIITEMR Director Yu.P. Zavgorodniy, "is the fact that the its data base is made up of basically dissimilar kinds of information—documentary and factographic. Without leaving the computer, the operator is able to access this quite diverse data put into its memory. Usually only abstracts of books, articles, reports, etc., are entered into information systems, in order to alleviate as much as possible the 'library anxiety' of engineers. The essence of the system boiled down to reducing the amount of information stored and to facilitating the use of it. We organized an integrated database of nontraditional information: These same abstracts, as well as detailed descriptions of equipment and data on the results of its use—in a word, very diverse information—went into it. Because of the presence of such broad multiperspective information and the ability to work with it freely, in sitting at the keyboard of a personal computer you experience the sensation of a real business conversation with an expert consultant."

Terminals will be installed in the design and engineering offices of the largest machine tool building plants. This year they will appear at the Krasnyy Proletariy Plant, at the Odessa Machine Tool Building Association, at the Moscow VNIILITmash [All-Union Scientific Research Institute of Foundry Machine Building, Foundry Engineering and Foundry Production Automation], etc. All organizations belonging to the machine tool and tool industry will receive free access to the information in the future.

UDC 681.324

Computer Network Used To Perform Tasks of Branch Management Automation

18610170 Kiev MEKHANIZATSIYA I AVTOMATIZATSIYA UPRAVLENIYA in Russian No 1, Jan 88 pp 57-58

[Article by A.I. Prudnikov and Ye.V. Lebedev]

[Text] Computers located in different cities throughout the UkSSR are being used by Ukrglavsnabsistema [the

Ukrainian Main Supply System] Industrial Engineering Association (PTO) of UkSSR Gossnab [State Committee for Material and Technical Supply] to perform the tasks entailed in managing material and technical supply. More than 40 such tasks and task sets are currently in industrial operation. The most important are as follows:

- online (daily) monitoring of shipments of metal products by enterprises of USSR Minchermet [the Ministry of Ferrous Metallurgy];
- online (daily) monitoring of coal shipments by enterprises of USSR Minugleprom [the Ministry of the Coal Industry];
- online (daily) monitoring of cement shipments by enterprises of UkSSR Minpromstroymaterialov [the Ministry of the Construction Materials Industry] to particularly important construction sites;
- monitoring (monthly) of the traffic and surpluses of essential types of products supplied to the enterprises of UkSSR Gossnab;
- monitoring (quarterly) of client-enterprises' surpluses of essential types of products;
- monitoring (monthly) of the fulfillment of the production plan and product shipments by enterprises of the machine building ministries;
- monitoring (monthly) of shipments of spare parts for agricultural machinery;
- monitoring (monthly) of shipments of essential products to the ministries and departments handling the Supply Program;
- compiling (monthly) summary reports of financial accountability forms (1-f, 5-f);
- keeping track of personnel changes (quarterly).

Figure 1 is a diagram of the network's information-gathering process. A hardware complex consisting of computers, data transmission equipment, and communications channels receives and sends data between the main enterprise (in Kiev) and production computer centers [PVTs] of the Ukrglavsnabsistema PTO attached to the main territorial administrations (glavsnabs) of UkSSR Gossnab (in Vinnitsa, Lvov, Donetsk, Dnepropetrovsk, Kharkov, Odessa, Simferopol, and Zaporozhye).

The source data files are sent via long-distance telephone channels from the production computer center to the main enterprise where they are either processed on a computer to produce reports or loaded into data bases so that the information can be output to displays located at workstations at UkSSR Gossnab and ukrglavsnabsbyts [Ukrainian main supply and sales organizations].

Dedicated long-distance and local communications channels [VK] that are leased from the UkSSR Ministry of Communications to operate round the clock are mainly used for sending and receiving data. Dial-up communications channels [KK] are used as stand-by dedicated channels. Besides their main purpose, these channels are also used for departmental long-distance telephone communications and for sending selector messages, facsimile and teletype communications between the organizations of the UkSSR Gossnab.

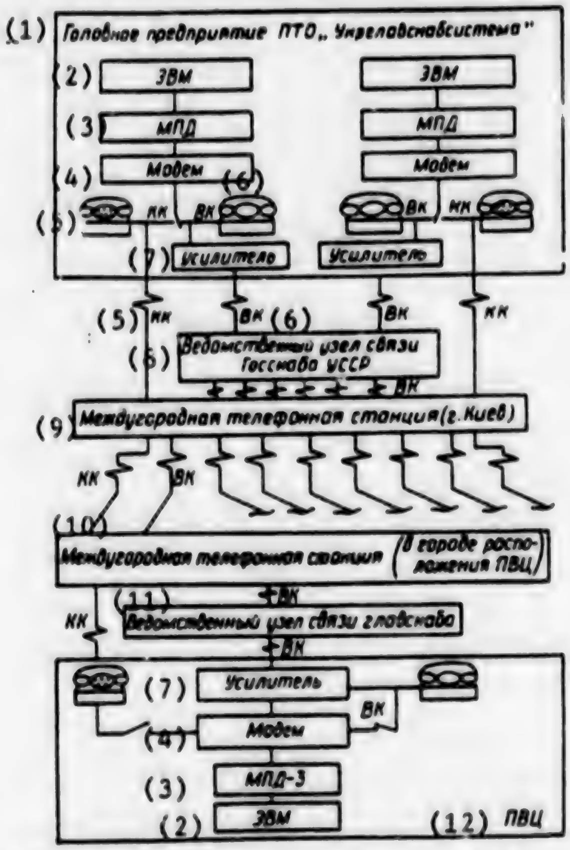

Figure 1. Diagram of the computer network's information-gathering process.

Key: 1. Main enterprise of the Ukrglavsnabsistema PTO 2.Computer 3.Multiplexor 4. Modem 5. Dial-up channel 6. Dedicated channel 7. Amplifier 8. UkSSR Gossnab departmental communications node 9. Long-distance telephone exchange (Kiev) 10. Long-distance telephone exchange (in city where production computer center is located) 11. Gossnab departmental communications node 12. Production computer center [PVTs]

A software package that makes it possible to send data reliably, eliminate soft failure situations occurring in a communications channel, compress information so as to reduce data transmission times, and connect user applications programs has been developed at the Ukrglavsnabsistema for use in conducting intercomputer information exchange sessions.

To ensure the reliability and completeness of the information being sent, the number of records is calculated, and they are added together cyclically in the computer at the data transmission point. They are subsequently compared with the analogous result obtained at the receiving point after the communications session has been completed. If the results obtained do not coincide, the receiving point requests a repeat transmission.

The system includes a mode for continuing an information exchange from the point of an interrupt. Because the

software for exchanging information between computers requires a minimal amount of RAM (50 Kb), intercomputer exchange may be implemented in a multiprogram mode.

The reliability of information transmission is determined mainly by the reliability of the hardware involved, the manner in which it is connected, and the quality of the local communications lines used in the dedicated channel system.

Because information exchange between computers entails coordinating the actions of personnel from computer centers that are rather distant from one another, it is necessary to work out a number of organizational problems, for example, establishing a data reception-transmission schedule, determining the order in which exchanges between computers will be conducted, rescheduling for missed deadlines, etc.

The following actions are necessary to increase the quality and reliability with which tasks are performed in the computer center network:

- make the hardware complexes (computer-data transmission equipment) redundant in all production computer centers to avoid missing deadlines for data reception and transmission in the event that just one of the system's hardware components fails;
- automate the computer operator's work pertaining to establishing communications and carrying out procedures for copying the files received;
- use advanced programming systems to check the source information being prepared at the production computer center;
- develop and use a system of active penalties for missing deadlines when presenting primary source information at the production computer centers.

Software that makes it possible to automate the process of gathering and sending information has been developed and is now being used at Ukrglavsnabsistema. Most of the time, the collection system at the receiving point functions in a wait mode for the arrival of information. The transmission program at the source points only functions during an exchange between computers.

The creation of the UkSSR Gossnab's computer center network has made it possible to decentralize data preparation and, as a result, to reduce peak loads during information processing at the main enterprise, permit one-time data input into the system, increase the information transmission reliability, and use the results obtained when performing some tasks as source data for other tasks. This in turn has made it possible to reduce the volume of accounting documents sent to the top management level by workers at supply and sales organizations. Furthermore, the substantial reduction in the amount of time needed to perform tasks has made it possible to provide UkSSR Gossnab workers with up-to-date information that they can use in making crucial decisions about the management of the material and technical supply of the national economy.

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Scientific-Technical Progress, Advanced Experience in Machine Building Problems of Robotization in Machine Building in Kazakhstan

18610037a Alma Ata NARODNOYE KHOZYAYSTVO KAZAKHSTANA in Russian No 9, Sep 87 pp 22-31

[Roundtable discussion moderated by Candidate of Technical Sciences L. I. Slutskiy, associate professor in the Department of Applied Mechanics of S.M. Kirov State University, Kazakh Republic, and scientific secretary of the Council of Robotics]

[Text] Mechanization and automation of production on the basis of making wide use of industrial robots and manipulators is acquiring a particular urgency in Kazakhstan in connection with the accelerated development of machine building and the increasing shortage of labor resources.

At the same time the rate of introduction of effective means of automation, robotic, rotary and rotary-conveyor systems in the republic are considerably lower than the all-union rate. Therefore one can scarcely overvalue the generalization of experience in robotizing production, the solving of problems which arise in the creation of "intelligent machines," and their introduction and operation.

The problems of robotization in machine building in Kazakhstan were discussed at a round table seession of the journal NARODNOYE KHOZYAYSTVO KAZAKHSTANA organized on the initiative of the Kazakh Republic Governing Board of the NTO Mashprom [Scientific and Technical Society for the Machine Building Industry], the Scientific-Methods Center for Robot Engineering, and KazNIINTI [Kazakh Scientific Research Institute of Scientific-Technical Information and Technical-Economic Research] under the Kazakh SSR Gosplan. The statements of the participants are published in this issue.

The moderator for the session was L.I. Slutskiy, docent of the Department of Applied Mechanics at the S.M. Kirov State University, Kazakh Republic, secretary of the Republic Council on Robot Engineering, and candidate of technical sciences.

Moderator:

A wide spectrum of participants has been invited to this meeting: not only are machine builders present, but also representatives from other branches. This was done for a special reason, because any experience in introducing robots and manipulators may turn out to be useful. For example, in the light and local industries of the republic

there are a great many industrial processes which lend themselves to automation: forging, extrusion, etc. Robot equipment is being introduced at a number of enterprises of these branches.

Greater development was given to the priority direction of automation at union-level enterprises. These include the prize winners in the republic competition on the introduction of robot equipment—AZTM, and the Aktyubrentgen and the Pavlodarsk Tractor Plant imeni V.I. Lenin production associations.

Therefore the discussion on how the republic program of robotization is being realized will begin with the representatives of the collectives which have achieved the most tangible results.

How the Program Is Being Realized

V.M. Degtyarev, chief of the Department of Mechanization, Petropavlovsk Machine Building Plant imeni Kuybyshev:

We began our involvement with robotics in 1980. The robot engineering complex was developed and introduced using our own resources. It contained two BRIG-10 robots and five machine tools. This "firstborn", used for manufacturing the crankcase and centrifugal cam of tractor axles, survived and is still operating today. One man services it.

At first we had a design bureau, but it grew into a robot engineering laboratory. Such a laboratory is necessary. The branch industrial bureau sent us the developments of the housings for mechanical parts and the individual assemblies, but their electronics were poor. We had to work at it ourselves, and sometimes call in specialists from a neighboring plant.

We are introducing robot equipment on a gradual basis. The sections and shops are engaged in a search for robotization projects, and where it is possible suggestions are made. The most successful suggestions we include in the comprehensive plans for the 12th and 13th Five-Year Plans.

The next stage is the development and planning, which is controlled by the ministry. Thus annually we are supposed to introduce 18 robots, and in 1990—19. All of this is included in the national economic plan.

In Bashkir they have acquired five robotized systems, 12 1-V-340 machine tools with robots for removing the parts, and a section has been created which is serviced by four men.

We are developing robots of our own designs. However, calling them 'robots' is not completely accurate; their operation is inflexibly programmed. Two lines for the manufacturing of fuel cans are already in operation. The mechanical assistants carry out all the processes from start to finish: loading, drawing, beading, notching, trimming, and delivery to the washing station.

We are continuing work on the development of more efficient robots for loading machine tools.

P.I. Alekhin, chief of the FMS Department of Alma-Atinsk Electrical Equipment Plant:

The specifics of our enterprise do not permit us to proceed on a path of introducing robot systems that are rigid and nonadjustable. Therefore we are engaged in the organization of flexible production lines. Our inventory consists of several hundred items and several thousand parts, but the consignments are small. Thus conditions themselves compelled us to make the choice—to utilize flexible modules and later incorporate them into flexible automated systems. After two and a half years of operation the system has been brought up to the state of an experimental-industrial operation.

I will admit, we still have many unresolved problems, although four flexible modules based on lathes and a machining center have been set up, software and equipment are in order, and a system of mechanisms which assure the functioning of this system has been developed and readied. But the greatest misfortune which we have encountered is the low reliability of the robot devices.

Just what is a lathe from the point of view of contemporary control systems? It is a quite complex and unreliable piece of equipment. We spend up to 50-60 percent of the operating time repairing this equipment.

The experience we have gained in the operation of the modules shows that this is the direction which we should follow. But introduction alone is only a small amount of the work which is necessary for organizing flexible production on the level of even a complex. According to our branch methods a system is considered a complex if it includes at least three flexible modules, automated storage and retrieval, a control system, automated monitoring, diagnostics, and checking of equipment. On the level of a complex the following systems are also included: group control, process automation, and scheduling control. Performing tasks on this level requires a local computer network and the software for joining this equipment together. And the personnel have to be sufficiently qualified.

The main complication in the implementation of FMS are the tremendous capital investments. Around a million rubles have been spent on the complex which we are now developing. A great deal of work is being done with practically all of the scientific centers of the branch—those with whom we have contracts. But the return from investment in this has been small, since the developments that the centers have made are quite localized,and production tasks at the level of a complex requires they be combined.

At the present time in this country the effectiveness of FMSs is being reevaluated. On the one hand, economic calculation shows that in spite of the great capital investments the return from them is not great—around R16,000 a year. However, this does not take into account the lowering of production costs by R100,000 which is achieved by using FMS. That is why it is necessary to change the method of calculation.

P.I. Gorbachevskiy, engineer-designer of the Karagandinsk Heating Equipment Plant:

At our foundry, super-mass-production and large series production take place. We produce heating equipment: radiators and boilers. The first problem is the mechanization and automation of the production of cores and the equipment for casting. Such machinery is developed for us by the TsKPTB of the USSR Ministry of the Construction Materials Industry. We are introducing robotized complexes for the production of radiator cores. But we are experiencing the same difficulties—the quality of manufacturing and design shortcomings. There is virtually no assembly which we have not had to convert or change. The mechanical aspect of these robots is handled by the Department of Mechanization, and the control units and the control system by the ASU [Automatic Control System] Department, our specialists in electronics. Basically the bugs in these robots were worked out, only process problems remained.

We implemented a line for manufacturing cores on a pneumatic system. The mechanisms operate like robots—they dismantle the boxes, extract the cores, and assemble. A pneumatic line for cleaning boilers is in operation. But we cannot make do with equipment of such a level; there are still many manual operations which are labor intensive and almost unyielding to mechanization. Therefore our plans for robotization are quite extensive.

The plant intends to acquire the Kontur-002-m self-teaching robot for carrying out complicated movements during the enameling of parts. In connection with this I have a question for you, the participants of this meeting: Is there any experience in the use of such a robot in Kazakhstan, and what are its specifics and special features?

Moderator:

Yes, there is. I can familiarize you and anyone else who is interested in it during a working session.

P.I. Gorbachevskiy:

We are doing much to process and transform the metal ourselves. A successful example is our own home-made robot for removing the radiator castings from the chain overhead conveyor and feeding them to the tumbling barrel. And another one for removing the processed sections from the automatic and semiautomatic devices and delivering them to the assembly section. We are continuing work with robotized complexes for manufacturing cores.

A.R. Papp, chief designer of the Alma-Atinsk "Porshen" Plant imeni 23rd CPSU Congress:

We have a plant with typical assembly-line production. We produce pistons, bushings, pins and approximately 14 items of goods for public use. The level of mechanization is quite high—62 percent for bushings, 71 percent for pistons, and 58 percent for piston pins. Of the 1300-odd units of industrial equipment there are 948 metal-cutting machine tools, of which 558 are used in the main production, including 540 automatic and semiautomatic machines.

Stemming from the nature of production, we give considerable attention to cutting down the manual labor in operations of loading the metal-cutting machine tools with billets and unloading the parts from them. And our parts are heavy, the pistons weigh around 5 kg, and the bushings 16.5 kg. That is why our labor expenditures run from 60 to 1143 kg-m per shift. In intensity the labor for many operations is close to heavy manual labor.

We painstakingly sought means for mechanizing low-prestige operations. Since 1978 the collective at the plant has been mastering the production of automatic manipulators. We call them automatic operators. By 1980 we already had them involved in work on 80 items in the shops. The first automatic operators based on the blueprints borrowed from Kiev did not come to us on the Model 1722 machine tools. We learned to manufacture them in our own way. During the 11th Five-Year Plan, 108 automatic operators were incorporated in the operations of turning the sleeves and collars and boring the channels in the sleeve. Seventy-eight automatic operators were used in the main operations. Eighteen were used in the operations of coarse honing, and the remaining automatic operators in the operations of finishing. During the years of the past five-year plan an economic impact of around R200,000 was made from the implementation of home-made control equipment. Around 60 workers were freed from low-prestige labor.

Naturally the use of automatic operators is not a unique solution to the problem of cutting down manual labor. Long before the beginning of the 11th Five-Year Plan we developed 11 types of automatic manipulators with our own resources and brought test models up to specifications.

We settled on developing an automatic operator for machining, turning and undercutting the piston faces for the II-730 semiautomatic machines. The Novosibirsk Machine Tool Manufacturing Plant, the industrial organizations of our Ministry of Tractor and Agricultural Machine Building and the USSR Ministry of Machine Tool and Tool Building Industry could not offer us any

effective automatic devices for rough turning and undercutting of piston faces. And even at the present time there are no such automatic devices in the country, although we do have foreign automatic lines from Lasalle, Bure, and others.

In order to automate labor on the multiple-tool automatic lathe we had to construct seven mechanisms, and make provisions for installing of the spindle with an accuracy of 1-2° and orienting the piston. We attached particular importance to the design of the mounting mandrel. At the present time eight automatic operators are in operation at the plant for turning and undercutting the piston face. It can be stated that we with our own resources have created a microautomatic line. It contains machine tools for turning the piston pins, and manipulators which we have designed and produced ourselves. The line is operating.

During the process of introduction we came to the realization that until all 18 automatic operators were completed for rough turning of pistons, we would not see a tangible result. Each lathe operator services three semiautomatic devices and, with the norm being 887 parts machined, frequently turns out up to 1200. This productivity is not bad—approximately the same as in the operation of the four automatic operators which have been put into operation and are located in two microautomatic lines. For the time being one operator services the equipment (partial loading). When all 18 automatic operators are ready, his servicing area will double. The routine operation of mounting the parts on the receiver of a step conveyor has to be entrusted to robots, but it is difficult for automatic operators to carry this out. Maybe with time it will be possible to equip them with cassette magazine loaders?

On 16 October of last year I had to appear at the "Machine Building" pavillion at the VDNKh [Exhibition of Soviet National Economic Achievements] regarding questions of introducing automatic manipulator-robots. There the majority of representatives of Minselkhozmash [the Ministry of Tractor and Agricultural Machine Building] agreed that, where it is at least possible, we should use the simplest first-generation robots and automatic manipulators, and only at operations with more complex kinematics should we use mechanisms with electronic memory, real robots. Today there is the clear conception that the use of automatic manipulators, whose cost fluctuates around R4000-R8000, is profitable in mass production, but in positioning operations that repeat from month to month at the same work site, automatic operators are advisable.

We have around 230 automatic manipulators which we produced ourselves, and many automatic operators of 12 types, of which we are using 180 in main production, and the remainder in the manufacturing of pistons and pins. Thanks to this, since last year the plant has converted completely to automation of the production of pistons. And this yields considerable results in connection with the low cost of automatic operators which are produced (200 items cost us R780,000).

Earlier the plant had avoided acquiring industrial robots due to their unreliability, high cost and complexity of servicing. But practice showed the advisability of the integrated use of all means of automation, including industrial robots.

During this five-year plan at our plant it is planned to order and introduce 24 flexible manufacturing modules. We have already received the first modules and installed them in the shops. They are being assembled and checked out, and part of the conveyor system has been set up. Soon nine flexible manufacturing modules for rough machining of sleeves will be in operation.

It is possible to facilitate the acquiring of even expensive robots. For this the finance agencies have to resolve the problem of depreciation allowances for industrial robots and for computers in order to recover their cost, not over a period of 20 years as is called for today, but in 4-6 years as is done in Japan. This would facilitate the introduction and use of the newest equipment.

The experience of our plant shows that the active service life for automatic operators fluctuates from 4 to 10 years. This means that in producing R1.07 million worth of equipment we have come off the loser. In the last year of the five-year plan the ministry in a directive order mandates us to bring the volume of production of locally manufactured equipment up to R3 million. A considerable portion of this is made up of the manufacturing of special semiautomatic machine tools, automatic devices and automatic manipulators.

Moderator:

I will express the general opinion that there are few who are enthusiastic about automatic-control industrial robots. And the reason for this is that at many enterprises this equipment is not being used in a rational manner. First of all it is necessary to robotize the monotonous labor that is encountered in mass production. But for the large-batch production of items it is not advisable to install special-purpose equipment. Multiprogram control on an industrial robot can do wonders, while a plant which has only a small output product mix will set it up with one program and consider the equipment to have been introduced. But the tremendous expenditures for the "intelligent machine" are not being utilized fully.

Certain higher organizations, without looking into the situation, compel the introduction of robots everywhere. This is a stylish, automatic-response kind of requirement. It can even be stated that our robotization turned from the path somewhere. At present we are producing surplus robots, robots which have to be used somewhere. They are being circulated throughout the enterprises.

People have become worried, thinking about where to use such equipment. T. Moiseyenko, chief engineer at the Porshen Plant, complained: Ten robots have been detailed to us, I don't know what to do with them.

It is necessary to plan not for the introduction of robots, but for the specific release of a number of workers due to automation. And as this is done in each individual case, the engineer service should resolve everything on site, should make use of capabilities and priorities. The technical ideas of engineering personnel should be directed at solving problems of local machine tool building and technical fitting out in order to obtain a return.

It is necessary that in the beginning of economic accountability [khozraschet] an organization be created which would be responsible for automation, including robotization.

Not Only Develop, But Also Introduce

V.V. Zimin, Candidate of technical sciences, head of the Department of Special Machine Tools at the VNIIarmatura Institute:

For a period of 7 years in our laboratory 10 men using the brigade method have been involved in the creation of new specialized machine tools, automatic and semiautomatic machines. How does our organization differ from the standard? We know the traditional method well: A year of designing, a year for process planning, a year for fabricating the model, a year for refinement, and a year for introduction. Somewhere after 4-5 years some kind of machinery is introduced. But we are doing all of this more rapidly—all the stages in a year on the average. Those people who think of the innovation, they themselves make up the conceptual design, and right there with the help of the plant they fabricate it. Then our engineers work on the refinement.

Not long ago we had a record—we made a machine tool in one quarter. And there are cases of greater scope. We were commissioned to develop an automatic line for machining the plugs for ball cocks. We did it in 2 years, and on a fundamentally new basis. This line is still operating and is providing a good return. We issue an order in metal, and not simply technical documentation by the thousands, which frequently gather dust in bundles in the archives.

We have also made around 10 semiautomatic machine tools and an automatic machine for assembling stud bolts with nuts. In its time this automatic machine was considered a manipulator, but it is simple in construction. All told it cost R12,000. As an example, there is a similar automatic machine with two robots, where manipulators hold the stud bolts and turn them. Such a noisy, beautiful technical complex is available for R90,000. But how many people are necessary for servicing this expensive unit!

If the engineer's final goal is the fulfillment of a specific assignment, then he is in a position to solve it rapidly and satisfactorily. Under no circumstances is it necessary to make equipment for several institutes belonging to different departments. This must be entrusted to a specific collective.

Last year we developed a rotary line for the ministry. But is was not stated specifically that it was necessary to automate it. At present this line is located in Moscow, it machines slide valves for D-A15 parts. Productive capacity is 1,800 parts an hour. This line will be beneficial, although it is not complete, it is a test model. The technology is admissible only under actual conditions. And occasionally formalism shows up. As an example, 200 rotary lines were planned for the ministry, and these would be distributed throughout the enterprises, there would be no discussion of whether they were needed or not. That is, the task is presented backwards: make the rotary line, and what is it needed for—nobody is concerned with this. Thus instead of benefit there is harm.

It is necessary to automate heavy, monotonous labor, and the exigent problems, "competition" for the sake of the indicators. These things belong to yesterday. We should not have robotization for the sake of robotization.

P. I. Alekhin:

We must all work in the direction of comprehensive automation. And here computers play the main role. They make it possible to assure the flexibility and maneuverability to that equipment which can satisfy the requirements of small-series, series and even large-series production. All elements of automation, including robots, are satisfactory for some particular cases. But the greatest result is gained when they are used in a system.

It would be desirable to support the idea of creating a republic coordinating council on robot engineering. It will yield a great benefit to many branches of the economy.

Moderator:

We have considered the industrial problems. And now how is this new equipment being introduced at the enterprise?

M.B. Baybatshayev, docent, Kazakh Polytechnical Institute, candidate of technical sciences:

We are solving the problems of implementing robotization in nonferrous metallurgy. This concerns only the metallurgical processes. We are almost the first in the union, therefore there can be no talk about borrowing.

Nevertheless the experience in robotization which has been accumulated in machine building and metal working can be used in auxiliary production. But if we are

talking about metallurgical processes, then the situation is much more complex. There are no specialized robots for metallurgy. In developing them it is necessary either to adapt the series-produced equipment which we produce by adding some new functional capabilities to it, or to develop other types of specialized robots.

The specifics of the metallurgical industry are such that in the case of its robotization it is impossible to use the concepts of grouping or typification which are used in machine building. It is impossible,for example, to readjust metallurgical units like machine tools. All the industrial operations and processes are diverse in time and space. The comfortable conditions which exist in machine building do not exist here. There are very high temperatures, aggressive media, health dangers, and a high accident rate.

Earlier there were attempts to automate and to mechanize the industrial processes for which the use of robots was proposed, but the result was nothing. A robot with a developed control system is required, in order that it can execute complex movements. We were involved with industrial processes at the Ust-Kamenogorsk Titanium-Magnesium combine, particularly dispensing processes in the case of pouring magnesium. There they developed a robotized complex with an automatic manipulator for batching out the magnesium. We will be implementing a robotized complex for removing oxide films, which is based on the Universal-5-01 robot.

A robotized complex has been developed for the warehouse system for storing the finished production. This has its own specifics, because magnesium is a fire hazard and the robots have to be provided with special properties.

At the present time in connection with the transition to self-financing and self-support some of the specialists state that the introduction of robots is ineffective. But this happens only because robotization is artificially separated from the process of automation. It turns out that during the development of an ASUTP [automatic technological process control system], which has an influence on the final production and on quality, the plans for robotization and the expenditures for it are not taken into consideration in the collective result. It is necessary to engage in combined mechanization and automation. Then there will be no talk about what is economically advantageous today; actually many of the operations are useful in the following stages of implementation. The problem of how to replace the workers on the sectors with severe work conditions has to be assigned the paramount importance.

B.A. Tikhonov, chief of the Republic Scientific-Methods Center for Robot Engineering , candidate of technical sciences:

The Ministry of Local Industry of the Kazakh SSR is engaged in robot engineering more actively than others of the republic ministries. It had developed a branch republic program of robotization, in which it is stated that during the five-year plan the 12 metal-working enterprises should introduce several dozen different industrial robots and manipulators. This includes the Kzyl Tu association, which by itself will introduce 50 robots and 50 balanced manipulators.

But slipups also occur. Approximately 2 years ago specialists at the Republic Scientific-Methods Center for Robot Engineering by order of the Kzyl Tu PO [production association] completed a plan for automating the stamping of plastics. But the engineering service of the association placed this plan on the shelf and forgot about it. The Kharkovites and the Letts borrowed our developments and they will be implemented. It is a shame that they were not suitable for the Alma-Atinsk people.

D.A. Yunichev, designer at the Kzyl Tu PO:

We know nothing about the studies which were made for the association because the laboratory had been renovated completely. As the saying goes, we had to start from scratch. Attempts were made at using the KM-0103 robot for stamping. Our impression was that it still was not ready. It was necessary to readjust this equipment literally every shift.

There are also other complications. The workers turned down the manipulators because labor productivity drops when they are used, and this reflects on wages. But all the same we are compelled to automate this production; aminoplast and phenoplast powders are harmful to health.

We are working on Vilnius manipulators. We also have manipulators from Orenburg, but they are still not perfected, and because of them there is an overexpenditure of aminoplast for pressing and the dust content is increased.

E.K. Zubov, candidate of technical sciences, deputy chief of the Republic Scientific-Methods Center for Robot Engineering:

When I was working in Riga, I ran into the problem of batching out powder. The workers from the Leningrad Elektrosila PO turned to us at the Center for Robot Engineering. Being convinced that the batching of powders with the help of screw-type loading devices does not make it possible to achieve the desired accuracy of the batch, the Leningrad workers ordered several batching vibrating hoppers from us. For this purpose the capacity of the hoppers was increased and a control system was set up, making it possible to deliver the main batch in a powerful stream, and for achieving accuracy to add powder literally by the grain.

The Leningrad designers supplemented this vibrating hopper with a manipulator, in which the weighing mechanism was mounted directly on the "arm", and called it the "Klen system". The Kalmar molding powder device

for the charging of multi-impression molds, which was also based on a vibrating hopper, was manufactured and tested. Their series production was perfected at the VPTIelektro Institute in the city of Cheboksary.

The Vilnius comrades are using worm feeders for batching. But it is still necessary to convince us of the advisability of their introduction.

Moderator:

Certainly many of you are using today's meeting for making contacts and exchanging information.

Several of the engineering services from the machine-building enterprises of Alma-Ata consider robotization as the implementation of flexible automated manufacturing systems. But really not all have achieved such a level. For some this is the use of rotary lines, for others, the use of industrial robots, and the development of robot complexes which are common in metal working. But even there difficulties exist. As an example, take the cyclone separator for the Kzyl Tu PO. How many fought against it! And some of the enterprises are taking the path of using the simplest robots. They also are beginning to be used widely in machine building. It is necessary to turn attention to other elements of automation, to these same rotary lines.

By the way, what about automatic operators? At present in foreign articles it is being mentioned more and more often that the simplest specialized robots have the potential to replace multistage robot-manipulators. When we were filling the order for the Kzyl Tu production association we came to the conclusion that the use of industrial robots in such production is inefficient. We proposed a new design of automatic operator. It is calculated for one-two movements, is very inexpensive, and justifies itself economically much better than a robot. It would be desirable if our scientists had this direction in mind.

Robotization is treated in different ways abroad. In Japan, for example, the government makes large grants for robot engineering in order to maintain it on a high level. And in Sweden, just the opposite, the government does not give a crown to firms which are engaged in robot engineering in order not to emphasize it artificially. They are developing other means of automation there: automatic operators, automatic machines, rotary lines.

A.Ya. Karakosov, deputy chief of Department for Machine-Building Industry, Kazakh State Planning Committee:

As practice has shown, there is disarray here among those engaged in robotization: those who are themselves interested, those whose superiors compel them to get involved, or those whose life work compels them to seek ways of increasing the productivity of labor. There is still no system in the introduction of a prestigious direction for automation.

The introduction of robot engineering in our industries should stem from the need for easing heavy physical labor, and even in this case it is necessary to take the economic aspect into account: what are the expenditures and what will be result be. Every now and then we adopt a robot at a cost of half a million rubles, and we free two workers with a salary of R3000 a year.

I agree with the previous speakers. Robotization is not a goal in itself. As a rule a robot gives an insignificant increase in the productivity of labor, sometimes even less than the machine-tool operators themselves. But we anticipate that with its help the output of production will increase by a factor of 1.5-2. All the same it will not be possible to reach the limits which the Communist Party has set for us, the machine builders. Therefore it is necessary to use a comprehensive approach in working out a strategy for the automation of production processes. Where to use robots, where to turn to our old equipment, to use the automatic machines, semiautomatic devices, which were unfairly forgotten. And in addition to the robots we have the intelligent machines. Automatic machines with mechanical and hydraulic drives have worked for us for dozens of years, and fairly well. So what of the automatic devices we do not have! It is necessary to use the old equipment there where it is economically and socially justified.

All the same, in order to achieve double-digit increase in the productivity of the equipment it is necessary to implement FMS and rotary conveyors. This is our future, which we must be working on now.

For the coordination of scientific and designing concepts, for the introduction of what is new, it is necessary to have a republic center, not only one that hands down guidelines and methods, but one that has greater authority and capability. It is advisable to free it from being part of a higher institute of learning and make it an independent unit under the council of Ministers of Kazakh SSR Gosplan. And in this respect there is positive experience in the country. In Riga under the republic's Gosplan a center for scientific-technical progress has been created. It is called Orion. It operates on contracts, and it has total economic independence and self-support.

It is also necessary for us to seek out new forms of activity for such a center, which could not only coordinate operations in the area of automation, but also train the specialists, introduce new developments, prepare pioneer items, introduce them in production, and make recommendations.

The scientists and designers must show a return on their toil. The republic Scientific-Methods Center for Robot Engineering has been operating already for 3 years. But its return could have been greater. Frequently I have to visit the major machine-building centers: Petropavlovsk, Pavlodar, Tselinograd. There the engineering services of the enterprises and associations are trying to make

something, to invent something, they introduce it, and they keep it to themselves. You ask: what are you doing here—reinventing the wheel? There is a center for robot engineering in the republic. Their answer: Oh, we didn't know that.

It is still nice that we have large union-level plants, plants which have a powerful production base, and the scientific and design subunits which suggest, advise, and insist that new equipment be introduced. And what about republic-level machine-building enterprises? Basically they do not have their own base, or qualified specialists. They are doing without the support and help of the coordination center.

Moderator:

It is fair to note here that for the time being the development of robot engineering in the republic is not on a high level. Therefore even our own Kazakhstan innovations cannot be implemented everywhere. Thus at the Scientific-Methods Center there are readjusting, gripping and adaptive devices which are very nearly flexible types of equipment. But only some of these are being accepted and introduced by the engineering service at the Alma-Atinsk Plant imeni S.M. Kirov and the Proyektmontazhavtomatika Institute. Other enterprises have generally rejected them.

Benches are being developed for testing robots, we already have them in series production. But only at the Pavlodar Tractor Plant imeni V.I. Lenin production association have they introduced and used such a test unit successfully.

We have systems for training industrial robots, making it possible to cut down the time for reprogramming them greatly. But there are only a few such robots — positioning, profile-type — in the republic; you could count them on your fingers. These developments have not been widely distributed in Kazakhstan, but are being used throughout the Union with success.

E.K. Zubov:

The directions of our work include an increase in the productive capacity of robots and giving them greater flexibility and universality. The robots of the next generation are about to arrive. While the industrial robots which are in operation at present are receiving and transferring parts piece by piece, the newly created IR are grasping them by groups but issuing them piece by piece.

As a result of the implementation of the latest development the productive capacity of the robots has increased greatly. But the important question immediately arises: do we need this speed? Not when metal is being machined by cutting. What this means is that more productive process equipment is demanded. And it exists. There are presses in which only a maximum of 10-15 percent of their potential is being used. Why? The fact is that not every man can load the presses and unload them at the required rate. A press can produce 120 parts a minute, but actually only 6-12 are being manufactured. We are solving this problem step by step. A new modification of a robot which is able to load the press has been installed. The press operators are left with only the movement of orienting the billets. As a result the productive capacity of the press, and consequently the output of production, was doubled. Thus at this stage the simplest module-robot with a primitive control and conveying system makes it possible to free 5-6 of the 13 presses which are in a set. And there is still the possibility of improving the process even further: to introduce a recognition system, automatic orientation, etc. Literally, it is possible to have only 2-3 people remaining on a section where 15 workers now toil. But with the subsequent growth of these systems, the economic return will be reduced with each phase. Therefore, taking into account the conditions of our country, it is desirable not to strive for global' automation, but to use the simplest robotization in combination with mechanization to a greater degree.

The participants of the meeting stated that here in Kazakhstan our scientific-technical base is poor, and in connection with this the timely and complete introduction of the developments of Kazakh scientists is being suppressed. But in addition to a base it is necessary to have a well-thought out system of implementation. There is one in Latvia. There, the robot engineering center develops the primary documentation, investigates the effectiveness of the new idea, and acquires a test model. The engineering center adds further impetus and brings the idea up to the stage of industrial testing. In Riga there are enterprises which are producing robotized systems which have been developed at the center.

It is difficult to say what our path will be to the solution of this problem. In any case, with the Latvian variant of a system of implementation we would already have not only robots of a new generation, but also general-purpose loading devices, electromagnetic conveyor systems, automatic warehouses and depots, and many other new innovations.

Moderator:

By the way, we have the first link in the system referred to. Not only the collective at the republic Scientific-Methods Center, but also the department at the polytechnical and a number of other VUZes are engaged in robot engineering. We also have an organization that is analogous to the Latvian engineering center. This is the Kazmontazhavtomatika Institute which is doing design work. Unfortunately it is still the only one in the republic, and even the industries of Kazakhstan are not helping much.

V.A. Kaleyev, department chief of the Kazmontazhavtomatika Planning Institute:

The reason for the low volume of work being carried out for the enterprises of the republic is clear — our developments cannot be applied everywhere. Often it is

necessary to carry out assignments other than those that relate to our primary purpose. We are assigned tasks not only as a planning and designing subunit, but also as an industrial unit.

It is known that one robot with a machine tool cannot operate. Conveyor and peripheral devices, storage units, etc. are needed. And they have to be developed. It was necessary in practice to create a new technological service, to bring in specialists in electronics. We work with the customers with respect to the planning limits. But as a rule they do not ask how any particular robot system will function, but where have such modifications already been introduced. This suspicion about what is new speaks again about the unreliability of the systems which have been developed, including those mentioned in the catalog. And in the catalog around 300 names of robot equipment are listed, but only dozens are being introduced. It should be confessed—often in our own plans we include items which have previously been tested in production.

I am in agreement with those who have come forth with their views: we have to create a scientific-production association which would be engaged in a combination of scientific-research, planning-designing, and implementation operations, supervision by the inventors would be realized, it would perform servicing, and check on the course of operations of the equipment.

Moderator:

Many participants at the meeting have given special attention to the necessity of servicing the robot equipment. And by the way, a special organization has appeared in our republic—the Servis specialized industrial administration. What can be expected from this service?

A.P. Gurov, head of the Servis SPU [specialized industrial administration]:

We are a young organization, the gorispolkom [city executive committee] has only recently allotted us accommodations. We are engaged in the adjustment of NC machine tools and Soviet-built robot equipment. The sphere of our attention also includes the adjustment of type N-2-2, N-3-3, UTsM, UKM, 2-TO, and 2R-22 NC systems, contouring NC systems, and others.

Here the opinion has been expressed that robots are like nothing to us. But this relationship is the result of our insufficient technical education. For example, take a robot on the base of a column-loop. It performs conveying functions, it orients the billets in the lathe, it controls the process of machining, it removes and stores the parts. But the robot can be used only for warehousing.

How can our organization be useful? We give consultations, we conduct adjustment operations, and we carry out servicing to a certain degree. But we still do not have specialized equipment for this.

The staff is small, it is short of qualified specialists. Our wages are not great, and social problems are still not resolved, so it is not easy to maintain personnel.

Moderator:

Actually the personnel problem remains one of the basic, but still difficult to resolve, problems. For many years there were no specialists on robot engineering in the republic. True, at Kazakh State University an insignificant number of engineers have been trained, in the form of a so-called orientation in the area of robot engineering. These graduates remained basically in Alma-Ata. But in the meantime a number of higher institutes of learning have already begun training specialists in this priority direction.

Everything Depends on the Personnel

B.A. Tikhonov:

At the end of the past five-year plan our country overcame 10 years of lagging behind foreign countries in the production of robot equipment. By the end of 1985 around 50,000 industrial robots had been produced, which is almost half of the world inventory of these machines. True, our record for introducing them is coming along less well. More than a third of the robots are gathering dust in warehouses. And if measures are not taken for the effective utilization of this equipment, the gap between its application and production will increase even more: by the end of the 12th Five-Year Plan it is planned to triple production.

As you know, our republic is lagging behind many of the republics in robotization. Therefore, last year the State Planning Committee of the Kazakh SSR commissioned our center to formulate a republic scientific-technical program for robot engineering. It is expected to allow more than R100 million for this in Kazakhstan.

There are also plans for 35 robotized sections and lines, around 130 robot systems and individual industrial robots, and a large number of manipulators and warehouse stockpiling machines to be put into operation at the Tselinogradselmash FMS-shop, and at other associations and enterprises. It is also planned to introduce more than a dozen SAPR [CAD] systems (SAPR-tkan, SAPR-model, SAPR-construktor, and SAPR-teknolog). Meanwhile in Alma-Ata the second year is being taken up with the introduction of SAPR by specialists from the republic Ministry of Nonferrous Metallurgy, and interesting results have been achieved.

Such is the scope of robotization which is expected in Kazakhstan during the 12th Five-Year Plan. Personnel which are technically competent and creative are required for its rapid development. Where will we get them?

On order of Minvuz [the Ministry of Higher and Secondary Specialized Education] to the republic, since September 1986 groups of students have begun training at five VUZes in the robot engineering specialization. During the five-year plan it is planned to graduate 2,800 engineers. But, in the nature of an experiment at the Karagandinsk and Kazakh polytechnical institutes, similar groups of students will take a fourth year. And so there will be as many engineers in robot engineering as there are highly qualified automatic machine operators. As an example, the program on robot engineering for the fifth and fourth year undergraduate levels takes up all told 100 hours.

In a number of technical schools in Kazakhstan they have begun teaching courses in robot engineering. Thus at the Alma-Atinsk Industrial Technical School groups of automatic machine operators and machine-tool trouble-shooters are receiving training in this specialization. But we also need qualified workers—operators, trouble-shooters for NC machine tools and industrial robots. This brigade of more than 500 students at trade-union technical schools is already being prepared for graduation.

Since our educational institutions have still not trained one engineer or technician with a specialization in robot engineering, it is necessary that our Scientific-Methods Center engage in the retraining of personnel. But still we are engaged in this on a quite modest scale: two to four groups a year finish the month-long course.

V.A. Kaleyev:

Many of the contemporary robot-engineering specialists refer to the republic center as an alma mater. In it dozens of enthusiasts waged a unique campaign against illiteracy. And even now, even though it is not a self-supporting enterprise, we are expecting help and we are receiving it.

The equipment which we deal with is unique. It is necessary that it be maintained up to world-class standards constantly, that it be competitive. But while in Kiev, Leningrad and Moscow the engineers engaged in robotization and automation stand out and are noted, including in a material sense, you cannot say this about us, the Kazakhstan workers. It is necessary to arouse the interest of the engineering and technical workers.

A.V. Kuzmin, instructor at the Alma-Atinsk Industrial Technical School:

Within the framework of the traditional specialties which are available at the technical school it is very difficult to turn out the required specialists. The fact is that the order from the republic Minvuz changes the structure of the educational institution only partially. We have introduced a proposal to USSR and Kazakh SSR Minvuz concerning a change in the curriculum of the technical school. In the example of the Moscow Technical School we have proposed to turn out technological engineers, trouble-shooters for equipment in automated production, for NC machine tools and FMS, and trouble-shooting electrical engineers.

We also expect help from interested enterprises in the creation of a material base, and in the carrying out of training (in this respect, as an example we are being helped only by the Plant imeni S.M. Kirov and the Mining Equipment Plant in Alma-Atinsk).

V.G. Cherches, chief of the Administration of Educational Institutions, Kazakh SSR Gosprofobr:

We do not train workers for robot equipment separately. In the eight schools with a machine-building curriculum we have organized the training of trouble-shooters for automatic machine tools and NC manipulators. The first group of graduates, 30 men, were sent out to industry in the past year. Today 600 young men and women are engaged in this same program. With the further admission of the young people into these groups we have calculated that the graduating class will outstrip the introduction of new equipment at the enterprises.

For us the program for training such a category of workers is exceedingly complex. In connection with this we have carried out a retraining of all experts in industrial education on the different levels. Nevertheless, in the institutions there are not enough engineering and technical personnel with this kind of background.

We are feeling the shortage of equipment and training films. All told there are 22 NC machine tools and 28 robots and manipulators at our machine shops. We are counting on the help of our base enterprises. But we can only praise a few in this: the Ural Omega Plant and the Pavlodar Tractor Plant imeni V.I. Lenin production association.

At each plant for which the schools are training qualified personnel, it is necessary to create specialized training sections for automation and robot engineering.

V.A. Neverova, deputy chairman of the Kazakh Republic Managing Board of the NTO Mashprom:

The units of the NTO are taking part in the activation of creativity among the engineering and technical workers.

It has to be recognized that the scientific-technical society of the branch is essentially taking the first steps in the creation of robotization. A seminar with the title of Problems of creation and operation of flexible automated manufacturing systems was held last year. At it the problems of robotization in an FMS system were considered. Based on the results of an assignment in the city of Frunze for studying the advance experience at machine-building enterprises, urgent information was issued and it was directed to all the primary organizations.

In order to attract the young people into the task of solving the problems of robotization in machine building and to develop their engineering activity, our managing board conducted a competition entitled For the Best Scientific-Technical Development by the Young Scientists and Specialists in Computer Engineering. Many developers took an active part in it, in particular the young specialists from the republic's robot engineering center, the Aktyubrentgen production association, and the Pavlodar Sborochnyye mekhanizmy NPO.

Nevertheless all these measures reflected the problems of robotization indirectly. Therefore we began to conduct measures which were more purposeful. Thus a competition was declared from the best brigade on automation and mechanization with the use of flexible manufacturing and robot-engineering complexes, industrial robots and manipulators, the results of which will be summed up in the beginning of next year. We invite you to take part in this competition.

By the way, such competitions were conducted earlier by the republic NTO council. Unfortunately very few machine-building enterprises took part in them. These were the Pavlodar Tractor Plant imeni V.I. Lenin PO, the Aktyubrentgen PO, the Ust-Kamengorsk Instrument Plant, the Petropavlovsk Plant and the Porshen Plant. Our mission is to expand the circle of participants in this competition, the circle of those who think creatively, who labor over the solution of the most important technical problems. We think that the Robot-servicing equipment seminar will create a great impetus to the development of comprehensive mechanization and automation of the branch.

Moderator:

Facts have already been presented here that in places where they do not have sufficient scientific-technical information they are reinventing the wheel. What is the outlook for information servicing?

L.B. Mladentsev, chief engineer at the KazNIINTI, Kazakh State Planning Commission:

A new form of service is being introduced—the Inquiry-Response. It is not necessary to visit the institute for this. The specialists can make their inquires with the help of visual display terminals. We will hold a specialists' day and organize press centers for scientific-technical information. A solid dossier on robot engineering has been accumulated over 7 years and many scientists and engineers are using it.

The greatest shortcoming in the operation, and not just in ours, is the absence of an upward flow of information. This is why many, as the saying goes, "stew in their own juices" and reinvent the wheel.

The participants at the roundtable meeting became acquainted with the scientific-technical base of the republic's Center for Robot Engineering and were briefed on topics of interest to them. The following recommendations were adopted.

Recommendations of the Participants at the Journal's Roundtable

1. To consider the activity of the republic's Scientific-Methods Center for Robot Engineering as useful and promising. To acknowledge it advisable to expand the functions of this center in order to convert it into an independent base for solving the problems of automation and mechanization of production in the republic. For this it is recommended that a scientific-production complex based on it be organized with planning and production subunits, whose job it is to develop and produce for the enterprises of the republic small batches of devices for automation and mechanization, including robot equipment.

2. For the more effective introduction of robot equipment in industry, the ministries and departments of the republic have to improve their work on the specialized training and cross-training of engineering personnel, and to improve the planning and introduction of means of automation and mechanization.

3. The industrial enterprises should organize specialized subunits for solving problems of robotization; they should improve work on personnel support; they should give special attention to improving the methods of moral and material incentive of the workers in these subunits.

4. The republic managing board of the NTO Mashprom should be carrying out regular measures for the exchange of experience in the robotization of production with the involvement of representatives from non-machine-building branches.

5. KazNIINTI under the Kazakh SSR State Planning Committee should intensify the propaganda and information support in different forms as it pertains to questions of robotization of industry in the republic.

6. The sections of scientific-technical progress and advance experience from the republic managing board of the "Znaniye" society should conduct systematic lectures on robot engineering and organize the distribution of brochures.

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UDC 658.588.8:338.364

Improved Servicing of NC Equipment Sought

18610099 Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 12, Dec 87 pp 30-31

[Article by engineers S.P. Yemelchenkov and D.V. Chistov: "Improving the Servicing of NC Equipment Is Essential"]

[Text] The resolutions of the 27th CPSU Congress have defined the strategic policy of accelerating the economic development of our country. New and progressive technologies and automated types of production are being incorporated at industrial enterprises at a rapid rate. The manufacture of over 31,000 flexible manufacturing modules and about 1,400 flexible automated manufacturing systems (lines, sections) and over 124,000 NC [numerical control] machine tools is projected for the 12th Five-Year Plan [1].

Today's utilization efficiency level for the expensive equipment is low nonetheless.

One reason for this situation is the insufficiently high level of reliability of NC systems, which is leading to considerable losses due to equipment idle time.

Reducing equipment idle time is a most important and paramount task. If the cost of a single hour of idle time for an NC machine tool is taken to be R30 [2] for example, it is not difficult to calculate that with just one hour of idle time for the 124,000 NC machine tools that are being produced in the 12th Five-Year Plan, the country's enterprises will incur a loss of R3.5 million. A search for economic controls and incentives, along with purely technical measures, that ensure a rise in the vested interest of all who take part in the production, operation and servicing of the equipment in its uninterrupted operation is essential for the successful resolution of the task of reducing equipment idle time.

The operating practice of the overwhelming majority of enterprises shows that equipment idle time connected with delays in the execution of set-up and adjustment operations is unjustifiably high. It has already become the rule that the set-up and adjustment of NC machine tools at the user's goes on for one or two, and sometimes three or four, weeks after the set-up workers are called. The user does not have the right to commence set-up operations independently, since in that case he is deprived of the right to later warranty service. Delays in the fulfillment of orders are usually explained by the set-up organizations by a shortage of highly qualified personnel. This sort of explanation can hardly be deemed convincing, however, since in one to four weeks they have all the set-up workers on hand. Ensuring a reliable system where the day of manufacture of an NC machine tool is the day of its shipment, and the day of its arrival at the user's is the day set-up operations commence, would make it possible to provide the state with an additional reserve of from 2 to 8 percent of the yearly output of NC machine tools.

An analogous situation exists in NC machine-tool servicing operations. It is known that equipment idle time due to disrepair can total from several minutes to several weeks depending on the complexity of the repairs, as well as the level of the enterprise repair base.

NC machine-tool servicing practices show that from 3 to 10 percent of equipment is idle on a given day due to disrepair, which is a R4,000-per-day loss for each hundred machine tools. Under the existing system, the losses for equipment idle time are borne completely by the user. The suppliers of poor-quality equipment bear only the inconsequential expenses associated with repairing the defective unit or assembly, and even then only during the warranty period (1-2 years). It is obvious that this system does not foster a vested interest on the part of the supplier to raise the quality of his products. It is essential herein to differentiate the payment of losses for idle time from the equipment idle time itself; idle time caused by the poor quality of the equipment, regardless of the time period it has been in operation, should be paid for by the manufacturer. When defects arise through the fault of the user, all of the equipment idle time, as well as the cost of repairs and the defective assemblies, should be paid for by the user himself. In the face of prolonged idle time that exceeds the stipulated time period for a given specific instance, the payment of losses beyond the standard should be borne by the service organization doing the repairs. The role of the service organization herein can best be fulfilled by the NC machine tool suppliers, which in practice signifies a transition to a system of plant servicing.

Such a procedure will undoubtedly raise the vested interest of enterprises in reducing non-productive expenditures to repair their own products. Plant servicing will moreover stimulate a rise in the quality of NC machine tools produced, the improvement of diagnostics and flaw-detection systems, the assurance of unification and standardization of items and a rise in the skill level of personnel.

It is natural that the service organizations will have a vested interest in having major users in order to reduce the number of service points. Service support is in turn advantageous to the large users, since it leads to a reduction in expenses for the maintenance of repair services. It is not difficult to calculate that the users' fees to service organizations for repair operations will be considerably lower than the cost of independent servicing. The quality of repairs will moreover increase, since the user-enterprise, not possessing highly qualified personnel and a sufficient quantity of diagnostics and test-bench apparatus, cannot accomplish the repairs at the requisite level.

As for small and medium-sized users, in view of the high cost of complex equipment, they cannot always procure it expediently. Where there is a need for it they can place a work order with the major users, albeit (and this is very important) at increased prices. The cost of the orders can nonetheless often prove to be lower than the purchase, servicing and repair of their own NC machine tools, the more so as such repairs at small enterprises are rife with the danger of non-fulfillment of the plan. Outside orders are also advantageous to the large users, since their fulfillment is done at increased prices and, moreover, the opportunity arises of increasing equipment utilization, which is currently clearly inadequate.

The transfer of some of the funds from increased prices to the wage fund and the shift of the fulfillment times of the orders to the second and third shifts will create additional incentives for the machine-tool operators to work during those hours. Resolving the issue of outside orders is a matter of interbranch authority, but the advantage of such an approach is obvious for all branches.

We should especially dwell on the issue of servicing imported equipment. Unique difficulties and problems exist here. Instances of the relatively quick determination by the user of the defective element or assembly are common, but many weeks are sometimes spent on acquiring them (when they are lacking in the EIP). It is obvious that a search for a way out of this situation is essential. And foreign-trade organizations could have the first word here. When concluding contracts for the acquisition of imported equipment, they should stipulate the terms of service support with an indication of the maximum time periods for the delivery of replacement assemblies and elements over the whole course of operation of the equipment. The manufacturing firm should bear the economic responsibility for failure to meet the delivery deadlines. An analogous form of economic mutual relations should in turn exist between the users and our foreign-trade organizations conducting the procurement of equipment without a proper regard for service support.

Such measures will make it possible to involve the foreign-trade organizations more deeply in the cause of accelerating scientific and technical progress and will be a convincing indicator of their real contribution to fulfilling the resolutions of the 27th CPSU Congress.

Footnotes

1. Stroganov, G. "A New Stage in Production Automation", PLANOVOYE KHOZYAYSTVO, No 5, 1986, pp 9-23.

2. Tychkov, Yu.I. "Well-Defined Organizational Economic Concepts of FMS are Needed", EKO, No 3 (129), 1985, pp 58-64.

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All-Union S & T Conference on State of, Perspectives for Developing High-Output Forge, Press Equipment

18610102 Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 12, Dec 87 pp 33-34

[Article by N. M. Soldatov]

[Text] An all-Union scientific-technical conference organized by the Ministry of Machine Tool and Tool Building [Minstankoprom] and the USSR VDNKh [Exhibition of Achievements of the National Economy] took place at the VDNKh in Moscow.

Organizations and enterprises of Minstankoprom developing and making forge-and-press equipment, representatives of consumer branches, and scientists from a number of VUZes participated in the conference work.

The main goal of this conference was to introduce the progressive forge-and-press equipment being developed and built by Minstankoprom, to exchange the operating experience, and to discuss the urgent connected needs connected with improving the technical level, quality, and reliability of forge-and-press machines.

During the conference more than 30 reports were presented concerning the problems of developing and building progressive equipment for resource-saving pressure processing of materials.

N.M. Soldatov (NPO ENIKmash) gave a report on forging equipment entitled "State and perspectives of developing high-capacity forge-and-press equipment", in which he noted that during the 12th Five-Year Plan period Minstankoprom enterprises will substantially increase the production of different types of high-capacity forge and press equipment, including flexible manufacturing modules, rotary swaging machines, automatic hot die forging machines, automatic machines for finished blanking, and rotor and rotor-conveyor lines.

Production of presses for cold extrusion, pressing parts from metal powder, multipositional automatic presses for sheet stamping, etc., will be increased. The report describes the main directions of domestic forge and press development: use of laser technology for cutting out complex-shaped parts from sheet metal, increase in the number of NC-equipped forges and presses, increase in productivity due to automatic tool replacement, NC-assisted adjustment of machine parameters, installation of diagnostic and parameter controlling devices, etc.

Specialists from NPO ENIKmash and its plants V.B. Chizhik-Poleyko, V.A. Melnik, R.D. Lapsker, D.Ya. Levita, S.G. Gurvich, A.A. Larin, and V.I. Gusinskiy made their reports concerning the state and perspectives of developing and building forge and press machines for main technological processes (metal separation, sheet metal stamping, bending and straightening, three-dimensional swaging, plastic material processing, metal powder pressing, and cold three-dimensional stamping).

The reports of A.A. Borovitchenko and I.Yu. Pronin (NPO ENIKmash) and V.B. Byalskiy (NPO Kuzmash) covered the development of flexible manufacturing systems, automated lines for forge-and-press production, and rotor and rotor-conveyor lines.

Specialists from NPO ENIKmash I.M. Podrabinnik, V.P. Salov, and V.D. Nedomolkin reported on the perspectives for improving the technical level of forge and press equipment, increasing its reliability and quality.

I.M. Podrabinnik described in detail the direction of work to improve the technical level of forge and press equipment, which was specified in the branch and plant "Technical Level" programs. These programs for the main types of forges and presses specified the technical level indices and the directions of developing equipment designs, and the implementing of automation, control, management, and diagnostics in the machines.

The product mix of equipment included in the program takes into consideration the differing production requirements of various branches of the national economy beginning with one-off manufacturing and ending with large series and mass production.

V.P. Salov described the content and direction of works specified by the branch and plant "Reliability" programs, where the time of reliable forge and press operation during a day and week, and the time of operation before an overhaul are used as the basic reliability indices. The programs specify what measures need to be taken at various stages of scientific-research work, design, and manufacturing.

V.D. Nedomolkin described the work specified in the "Quality" program, which describes a series of measures to improve the technological level of forge and press production at the subbranch enterprises.

Realization of the "Technical Level", "Reliability", and "Quality" programs during the 12th Five-Year Plan period will substantially increase the competitiveness of forges and presses, and will help in accelerating the reconstruction of machine building and metal working branches.

L.A. Rabinovich (NIITavtoprom) [Scientific-Research Institute for Automobile Industry Technologies], B.M. Rigmant and O.S. Zhelezkov (VNITmetiz, Magnitogorsk) [All-Union Scientific-Research Institute for General Metal Parts Technology] reported on the state of and perspectives for developing the pool of forges and presses at enterprises of Minavtoprom [Ministry of the Automobile Industry] and Minchermet [Ministry of Ferrous Metallurgy].

These reports discuss also the design deficiencies of the domestic presses and forges operating at the enterprises of these ministries. Thus, B.M. Rigmant's report notes that the automated bolt and nut benches supplied to Minchermet by the Azov KPA plant, Chikment Forge and Press PO, and others, have only 30-60 percent of the productivity stated in the technical documentation. The supplied equipment lacks automated process control systems and devices for fast change of tools. It also lacks the efficient measures and devices to reduce the noise level to safe norms, and to remove gases.

The existing design deficiencies of the automated hardware that produces general metal goods delay the introduction of equipment into service and lead to substantial nonproductive expenses.

L.A. Rabinovich's report notes that the enterprises of Minstankoprom did not put in production progressive types of forges and presses, such as automated swaging benches, multiposition automated benches developing high stresses for cold stamping of parts with complex shapes, multiposition automated presses for sheet metal stamping with three-coordinate blank positioning, reliable small-size pattern cutting combined lines for laying-out coiled rolling stock, etc. The supplied equipment is not equipped with press tooling. Very few benches are supplied with devices to replace dies.

During the conference, reports were presented by MVTU (Moscow Higher Technical School) imeni N.E. Bauman, Kuybyshev Polytechnical Institute, and the Institute of Automation of the Kirghiz SSR Academy of Sciences concerning the development of specific types of forging and pressing equipment which widen the application of pressure metal processing.

A.G. Ovchinnikov (MVTU imeni N.E. Bauman) reported on work to develop presses for extruding parts with deep cavities. The reduction in pressing stresses is achieved by using the active friction forces.

The conducted research has shown that during extrusion with a floating die, the stresses on the punch are reduced by 10 percent compared with extrusion with a fixed die.

With a forced die movement in direction of the metal flow, the deforming force may be reduced by 20 percent. As a result, it is possible to extrude parts with deeper cavities in one stage without intermediate annealing.

For the effective use of such a deformation process, pilot presses with forces of 1.6 and 5 MN are being developed.

L.V. Nikolaeyev (Kuybyshev Polytechnical Institute) reported on the institute's work to develop multiplunger presses for bending large-size sheet parts with single or double curvature (as are used in shipbuilding and chemical machine building) without using expensive press tools. Control over the plunger cylinders is realized using an NC system.

M.Z. Almamatov (Institute of Automation of the KiSSR Academy of Sciences) reported on the institute's work in developing automated presses in which the Variable Structure Mechanism (MPS) developed by the institute's scientists is used as the main actuator. Its use allows one to get rid of control devices (switching mechanisms) based on the interruption of the kinematic chain and additional links between the frame and the actuator. The idea behind the MPS is a mechanism which changes its structure due to an insignificant change of one of its parameters. For example, hinged four-link chain becomes a crank-slider gear.

I.F. Brykin (Electrosignal plant, Voronezh) reported on the experience of operating automated forge-and-press machines for sheet metal stamping and bolt thread rolling. He noted the design deficiencies of the automated universal bending benches built by the Serpukhov experimental KPO plant imeni 8th Anniversary of October, automated sheet metal presses with the bottom drive built by the Ryazan Heavy Forging Equipment Plant, and the automated thread rolling benches built by the Azov KPA plant.

Top engineer V.A. Lyashchenko (Glavlenavtotrans [Main Leningrad Authority for Automotive Transportation], Leningrad) reported on designs of modular automated sheet metal stamping benches developed based on the author's inventions.

Based on the results of its work, the conference came up with recommendations, the implementation of which will cause wider acceptance of new progressive types of forging and pressing equipment in industry.

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New Foundry Equipment

18610001 Moscow AVTOMOBILNAYA PROMYSHLENOST in Russian No 5, May 88 pp 30-31

[Unattributed article: "Foundry Production"]

[Text] Foundry production is one of the oldest, and perhaps for this reason, one of the most strenuous. But in recent years, scientific-technical progress has made increasing inroads even here: the equipment is being renewed and new technologies introduced. Among the most important projects concerning modernization of technology and automation of production in the casting shops of the sector we should mention the creation and universal adoption of automatic molding lines integrated-automated precision investment casting shops, an integrated-automated shell casting shop for crankshaft, a family of automatic and semiautomatic core-making machines, mastery of a pressurized casting production of cylinder blocks (GAZ engines), and much else.

The largest casting departments of the plants in the sector correspond in level of automation to the most rigorous demands currently imposed on foundry production. This is shown, in particular, by the displays of the exhibit, some of which are discussed below.

Specialists of the NIITavtoprom scientific production association and the Kharkov subsidiary of the VNIIlitmash have developed and built at the Tiraspol Casting Machine Plant imeni Kirov the MODEL 62001 AUTOMATIC LINE for production of foam polystyrene model blocks. Compared to the equipment presently in use, this increases the labor productivity by a factor of 2.5 and reduces the net cost of fabrication of castings by 25-30 percent. The line operates with two manipulators: one to move the assembled model blocks from the automatic assembly machine onto an accumulating conveyor and one to place the downpipes on the turntable of the automatic assembly machine. The line is controlled by microprocessor. The annual economic impact is 290,000 rubles.

Specifications of Line

Productivity, blocks per hour	50
Dose of injected model compound (nonfoamed polystyrene), cm^3	10-120
Outside dimensions, mm	4625x4300x2650
Mass, kg	15700

At the KamAZ, the MODEL MO-3 Semiautomatic Machine has been developed and built for removal of fins and remnants of the feeders from cast parts of automobile spring block type and other castings of similar configuration or dimension, with an appropriate retooling. The machine has higher productivity (240 pieces per hour) than its counterparts and better quality of machining, thanks to the use of a new design of vertically closed chain conveyor with accessories and tools mounted on it for machining the castings, provided with flexible elements. The net production cost is lower and the design is simple. It can work in manual or automatic control. Loading of the castings is mechanized (using block and tackle). A single person attends the machine. The annual economic impact is 23,200 rubles.

Specifications of Semiautomatic Machine

Actuator	hydraulic
Oil pressure in hydrosystem, MPa (kg/cm^2)	6 (60)
Power consumption, kW	20
Mass of casting, kg	31.2
Outside dimensions of machine, mm	3500x2500
Mass (with hydraulic seal), kg	2500

Worthy of interest is the MODEL 4167 Casting and Forging Machine for fabrication of shaped parts of nonferrous alloys weighing up to 2 kg (e.g., lubrication, pneumatic and fuel equipment). It was developed by specialists of the NIITavtoprom scientific production association and is being adopted at the Minsk, Gorkiy and Volga motor vehicle plants.

Advantages of the new machine compared to existing ones are the possibility of using ingot materials and production wastes instead of rolled metal as the starting material; less work area thanks to elimination of between-step process blanks and handling of rod material; high productivity (110-1600 piece/h) and accuracy (tolerances of forged pieces held within 0.1-0.12 mm); improved mechanical properties of metal thanks to hydrostatic compaction, elimination of porosity, less internal stress during formation of finely dispersed structures; possibility of controlling the entire process and monitoring all steps by a single person from the console. The economic impact from adopting one such machine is 100,000 rubles per year.

Specifications of Machine

Mass of blank, kg:	
Brass	2.0
Aluminum	0.6
Pressure in hydraulic system, MPa, from:	
High pressure pump	18
Low pressure pump	5.5
Multiplier	28
Number of hydraulic cylinders	9
Table stroke, mm	59
Installed power, kW	68
Compressed air outlay, m^3/hr	19.2
Outside dimensions, mm	6895x4140x3380
Mass, kg	15500

The NIIlitavtoprom is the developer and builder of the MODEL 4748 Core-Making Machine, which is operating at the Svobodnenskiy automotive spare parts factory and provides an annual economic impact of around 52,000 rubles. Its mode of operation is based on sandblast filling of the core box with mixture. It is a single position machine. There is a movable sandblast reservoir, traveling from the mix loading position to the position for blowing the mix into the stationary core box with vertical joint plane and built-in electric heating tubes.

There is a load-lifting device for installing and removing the blowing plate and the sandblast sleeve, which also raises and positions the core box. The noxious gas released upon hardening of the mixture in the core box is localized and removed by special ventilators, connected to the ventilation system of the shop.

The machine operates in step-by-step or semiautomatic mode. Control is by a system of electronic components.

Specifications of Machine

Productivity, core/hr	10-15
Mass of core, kg	25
Installed heating power of core box, kWh	60
Outside dimensions of machine, mm	3835x3480x2920
Mass, kg	6900

The Model 4174 Single-Position Layout is designed for production of precision castings of ferrous and nonferrous alloy. Thanks to the upper heating and pressing plate, it is possible to obtain a distinct imprint on the opposite face of the mold-half. Heating at both ends reduces the setting time, thus boosting productivity.

The design of the modeling plates enables quick change. The original design of the pushing system allows production of half-molds of 300x300, 300x600, 600x600 mm when necessary. The finished half-molds are automatically removed. The layout is simple to operate and attend.

Specifications of Model 4174 Layout

Productivity (with setting time 30-420 s), batches/hr	60-8
Outside dimensions of mold, mm	600x600x12 divided by 50
Volume, m^3	
Hopper	0.47
Dispenser	0.035
Heating temperature of equipment, K (C)	473-523 (200-250)
Method of heating equipment	electric
Type of actuator	pneumatic
Installed power, kW	53
Outside dimensions of layout, mm	4025x1480x2610
Mass, kg	4900

The layout has been introduced at the Melitopol Avtotsvetlit Plant imeni XXVI Congress of the CPSU with an economic impact of 77,000 rubles. The developer and builder is the NIITavtoprom scientific production association.

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Interdepartment Repair System Is Efficient

18610037b Alma Ata NARODNOYE KHOZYAYSTVO KAZAKHSTANA in Russian No 9, Sep 87 pp 32-37

[K. Sarsembayeva, junior scientific collaborator KazNIEIPiN]

[Text] It was noted at the 27th CPSU Congress that a considerable share of productive capital has become obsolete, as a result of which the sphere of major repair has become excessively inflated.

This all-union problem is aggravated in the Kazakh SSR where there is a very low density of disposition of metal-working equipment. It is concentrated mainly in the cities, especially in the major cities such as Alma-Ata, Karaganda, Pavlodar, Ust-Kamenogorsk and Chimkent.

In spite of this, there is not one repair plant of the USSR Ministry of Machine Tool Building in the republic for overhauling machine tools. Kazakhstan (with the exception of the machine-tool enterprises in the Ural Oblast, which are attached to the Michurinskremstanok Plant in the Tombov Oblast) is included in the service territory of the Sibremtochstanok Plant which is located in Novosibirsk. The services of the visiting brigades from the repair plants are also not cheap—R2,700-3,100 for one machine tool. All the same, users of the equipment are forced to avail themselves of these services, since the conditions in the available repair facilities do not lend themselves to qualitative major repair.

Moreover the distance that the machine tools and machinery has to be shipped is great. From the Kentausk Excavator Plant the equipment is first delivered to Chimkent, then by railroad to Novosibirsk, for a distance of 2,433 km. Thus specialized repair of the model N481A equipment cost the enterprise R11,961. Annually the Eastern Kazakhstan Machine Building Plant has to repair 10-15 machine tools of the 1K62 model in Donetsk Oblast at the Snezhnyanskremstanok enterprise (distance—4,470 km).

For a period of 7 years the AZTM has sent 4-5 units of equipment annually to Novosibirsk to be rebuilt. The capital repair of one machine tool, including transportation expenses, costs this enterprise up to R1,500. The expenditures are comparatively low, but repair takes an average of a year, and the delivery of the equipment only one way takes almost 90 days.

One has to note that the inventory of equipment which is repairable by specialized enterprises is very limited. As an example, at the Sibremtochstanok Plant they repair coordinate-boring machines, but they do not overhaul boring, milling and gear-cutting machines.

The quality of repair does not always accommodate the clients. The Ust-Kamenogorsk Instrument Plant made such claims to the Sibremtochstanok Plant. And another case. The AZTM sent some equipment for rebuilding to the Orelremstanok Plant, where it was irresponsibly sent to the repair section. They ground the bed and replaced the gears, but the speed gear-box was left untouched. Such a "repair" could have been made at their own repair-machine shop and by the client himself. There was no need to ship it to the other end of the world.

When a machine tool is shipped from Alma-Ata to Novosibirsk the transportation expenses exceed 9 percent of the total expenses for having it overhauled. And it is convenient to ship loads there by railroad only for enterprises which are located in the eastern and southeastern oblasts of the Kazakh SSR. The expenses which have to be borne by the machine-building enterprises of the republic are shown in Table 1.

Table 1. Expenditures for the Transporting of Equipment From kazakhstan to Enterprises of the Soyuzstankoremnaladka VPO

Location of the enterprise-client	Location of the repair plant	Distance, km	Name of machine tool	Transportation expenses for a RR car in rubles
Alma-Ata	Novosibirsk	1,687	Engine lathe	212
Alma-Ata	Moscow	3,994	Coordinate-boring	363
Alma-Ata	Sumy	4,252	Milling	494
Ust-Kamenogorsk	Novosibirsk	780	Engine lathe	100
Ust-Kamenogorsk	Moscow	3,794	Coordinate-boring	460
Ust-Kamenogorsk	Sumy	4,155	Milling	407
Karaganda	Novosibirsk	1,076	Engine lathe	177
Karaganda	Moscow	2,9542	Coordinate-boring	363
Karaganda	Sumy	3,322	Milling	407

In the Kazakhstan region the expenses for transportation make up a considerable specific share of the expenses for overhauling equipment. Therefore in substantiating the centralization of a repair industry we considered this factor as one of the most important. With respect to a repair subbranch, transportation is a related branch. An improvement in it leads to an improvement in the efficiency of equipment overhaul. The problems of these spheres of economics should be considered together and the program for intensification of the repair industry should be developed taking into account the future development of transportation.

The interbranch centralization and specialization of equipment rebuilding is also efficient from the point of view of improving the transportation network. The intrabranch transportation of repair resources lowers the efficiency of transportation operations.

The share of Kazakhstan machine building and metal working in the corresponding branch on a national level comprises 1.8 percent. As is known, the organizational-technical level of the repair industry is higher in machine building. From this the conclusion can be made that the

republic is lagging behind considerably with respect to the level of equipment furnishing and the organization of the repair industry.

In 1986, expenditures for maintenance and operation of equipment in Kazakhstan industry were R2.8 billion, which included R408.4 million in machine building and metal working. The expenditures for major repair of machinery and equipment were R504 million and R41 million respectively.

Annually these expenditures are growing by R20-30 million in industry, by R1-2 million in the machine building and metal working branch, and by the same amount in the machine building subbranch.

In comparison with 1980, the expenditures for major repair of equipment in Kazakhstan industry in 1985 increased by a factor of 1.3 and in machine building—by a factor of 1.4. There are great resources in the "Repair of machinery and equipment" subbranch of machine building and metal working: it accounts for every third ruble of cost for industrial-production fixed assets and almost every second worker in this branch. During the 9th Five-Year Plan the numerical strength of industrial-production personnel in the repair subbranch increased by 3.9 percent, in the 10th—by 11.4 percent, and in the 11th—by 5.7 percent. Around 3,500 enterprises, shops and repair shops in the region are engaged in overhauling equipment.

There are repair services available at any machine-building enterprise at the union level. The author of this article inspected 29 such repair facilities at plants which are related to different subbranches of machine building. From 200 to 10,500 units of basic industrial equipment are installed there. Metal-cutting machine tools make up the most numerous and complex type. Their specific share in the machinery pool of the enterprises investigated is 50 percent. In turn, most numerous among the metal-cutting machine tools are the engine lathes. Their share is equal to 15.7 percent.

It is known that the diversity of the models of equipment hinders the specialization of its repair significantly. At the enterprises in the republic the number of different models of metal-cutting equipment gets to be significant. In particular, at the Eastern Kazakhstan Machine Building Plant there are 301 different models, at the Tselinogradselmash production association—312, and at the Pavlodar Tractor Plant imeni V.I. Lenin—593. The number of models of engine lathes is 34, 28 and 27 respectively. In the meantime the Pavlodar tractor builders have a single-model coefficient of 18 for the engine lathe group. Here it is possible to achieve a greater efficiency from the specialization of repair of equipment than at other machine-building enterprises, particularly as it pertains to the gamma-models 2A125, 2A135, 1K62, 1K625 and 1K625B.

Seven percent of the entire pool of main production and 9 percent of metal-cutting equipment are installed in repair services of the investigated enterprises. In view of the unique nature of operations, the utilization factor of machine tools here is very low: between 0.6-1.0 in the mechanical repair shops and 0.4-0.8 at the shop repair bases.

The RMTs [mechanical repair shops] and TsRB [shop repair bases] are not provided with sufficient work areas. Frequently the equipment has to be overhauled in spaces which are tight and not very suitable. At the plants and associations which were inspected the overall area for one repair service was 2,363 m^2 on the average, a mechanical repair shop—1,437 m^2, and the shop repair base of one enterprise—602 m^2. At the RMTs for a unit of main production equipment there is an average of 36.2 m^2, and at the TsRB—21.3 m^2.

The production area which is provided for one machine tool is particularly low at such enterprises as the Makinsk Piston Ring Plant, in which the RMTs area is 15.9 m^2, and TsRB—8.1 m^2, the Pavlodar "Oktyabr" Experimental-Test Plant—21.3 and 16.0 m^2 respectively, and at the Tselinogradselmash association—30.8 and 13.5 m^2. But based on the existing standards for a unit of main equipment in the mechanical repair shops of machine-building plants there should be no less than 40-45 m^2 of production area, and at shop repair bases—27-31 m^2. Consequently, a given machine tool installed in an RMTs is provided with an area which, on the average based on the enterprises inspected, is 84 percent of the standard, and at a TsRB—73 percent, or, the average specific area per unit of equipment with respect to repair servicing is lower than the standard by 8-10 m^2.

One of the most important resources of the repair industry is its personnel. In the group of plants and association under consideration 7 percent of the industrial-production personnel of an enterprise are engaged in repair work on the average. This is 3-5 points lower than the same index for machine building for the country. However, this index fluctuates from 3.7 percent at the Kokchetav Instrument-making Plant to 17.9 percent at the Taldy-Kurgan Alkaline Cell Plant.

The mechanics and machine tool operators are the leading groups of repair workers. The specific share of mechanics in the overall number of repair workers is 66.7 percent, and machine-tool operators—19.2 percent. At some of the plants these indices deviate considerably from the average values. Thus the share of mechanics can go up to 87 percent, and machine-tool operators—up to 30 percent. Unsatisfactory work conditions, a predominance of manual labor, and lower wages than for the main workers are the reasons for the high turnover among repair workers. Most often they leave for the main production. But the reverse phenomenon is also observed: it stems from moral dissatisfaction with the monotony of work of machine-tool operators, and also in connection with releases as a result of robotization or

certification of work sites. The average skill-category of repair workers in the machine-building industry of the republic is equal to 4, and the level of mechanization of their labor—20 percent, which naturally is far from adequate.

The enterprises of an overwhelming number of union, union-republic and republic ministries and departments are located over the entire territory of the Kazakh SSR. Without a doubt intrabranch centralization and specialization of the repair industry improves its indices, but under conditions of a vast region with a relatively small pool of machine tools it is not much. The problem of shipping equipment, spare parts and materials is aggravated not only the increasing transportation expenses, but also by considerable inconveniences, such as assembly and disassembly of the machine tools, their loading and unloading, and a prolonged period of time en route.

In connection with this the individual ministries of the republic are centralizing the repair of equipment within the limits of the major oblasts. As an example, a repair shop has been set up in Karaganda and the machine tools and machinery from the enterprises of the branch which are located in the neighboring territory are overhauled there. In the near future it is planned to organize such repair subunits in Pavlodar, Ust-Kamenogorsk and Kustanay.

It is planned to put the Minmestprom [Ministry of Local Industry] and the Minbyt of the Kazakh SSR on the path of centralization in the overhaul of equipment. The locations selected by them for the setting up of specialized repair enterprises basically coincide. The KazKT-PImestprom Institute has recommended that repair shops be set up at the major enterprises of its own department in five large cities and that other industries be serviced by visiting brigades. However, these recommendations have still not been carried out.

An analysis shows that the pool of metal-cutting equipment from the ministries and departments which are subordinate to the Kazakh SSR Soviet of Ministers is small. One of the largest ministries, the Minmestprom, has 2,465 such machine tools. Of these, 10 machine tools of one model are receiving major repairs in a year. According to the calculations of the ENIMS [Experimental Scientific Research Institute of Metal-Cutting Machines] this should be no less than 100 units year, which is the main criterion when substantiating the setting up of specialized repair enterprises. This means that we need to start with all the metal-working equipment in operation in the republic's economy. Therefore the one acceptable, most rational approach for our republic is the interbranch centralization and specialization of the repair of metal-working equipment. We should direct our efforts immediately on its organization, without scattering our efforts on the intrabranch separation of labor.

During 1977-1980 the scientific-research theme "Proposals for the Centralization and Specialization of the Repair Industry" was being exploited in the country. NIEIPiN of the Kazakh SSR Gosplan was one of 25 co-executors. The institute introduced a proposal for the creation in the republic of two specialized enterprises for the repair of metal-cutting equipment. Investigations continued at the Gosplan level. The volumes of machine tool repair per year of the 12th Five-Year Plan from the point of view of the republic ministries and departments were determined. Of all the various locations for siting the repair enterprises, the most acceptable were Karaganda and the workers' settlement of Burunday in Alma-Atinsk Oblast. The setting up of plants in Karaganda is possible on a base of the existing uncoordinated repair industries.

Table 3 contains a list of the models of machine tools and their numbers which have been proposed for centralization.

Table 3. Calculated Program of Repair Plants by Type of Metal-Cutting Equipment

Gamma-model of machine tools	Repair plant in Karaganda	In the workers' settlement of Burunday
Total	2365	1324
which includes:		
1A62	391	261
1K62, 1K625, 1K625B	698	466
1A616, 1A61611	293	196
1341	93	—
163	56	—
111365	27	—
2A125, 2A135	602	401
6H81, 6H811, 6H11	205	—

Thus in Karaganda it is planned to overhaul 2,365 machine tools of the 8 gamma-models annually, and in the workers' settlement of Burunday—1,324 units of 4 gamma-models. Calculations also show that for the construction of the repair plant in Karaganda R15 million is required, and in Burunday—R8.4 million of capital investments. It will pay for itself in 3.1 years.

Under the existing organization of the repair industry in Kazakhstan the expenditures for major overhaul of 3,689 machine tools is R26 million a year. Their overhaul at the specialized enterprises would cost R17 million. Thus the economic efficiency of the proposed repair plants can be estimated as a total of R9 million a year.

In our opinion the setting up of the repair plant in Karaganda is the first and foremost task. The city occupies a central position relative to the entire territory of the republic. The selection of this point is economically substantiated: it has the lowest transportation expenditures for the region, the highest concentration of

the main metal-cutting equipment in a radius of 600 km, the presence of a railroad, and a developed construction and metallurgical base. In accordance with the time restrictions, the proposed enterprise should undergo capital repairs at the same time as modernization. Projects for such improvements are being developed at the Central Planning and Design and Technological Bureau of Automation and Modernization of Existing Metal-Working Equipment which is located in Tula. The organization of a branch of it in Karaganda and the involvement of the local university and polytechnical institute could serve as a base for the creation of the Remstankomod educational-scientific-production association.

The setting up of repair enterprises should not be connected only with new construction. We should also study the experience with organizing them initially by relocating them in small buildings that have become empty and the further development of their capabilities. Also with the centralization of production of goods for general machine-building application, industrial sites would then become available for the organization of interbranch repair of equipment.

At a meeting of the CPSU Central Committee on problems in the acceleration of scientific-technical progress (1985) it was noted that "We cannot do without new construction. But it is necessary to take a close look at the projects under consideration: to accelerate the construction of some, and others—discontinue or even shut down temporarily." Without a doubt, in such a major rayon as Karaganda construction has begun on buildings which belong to non-machine-building ministries. It is advisable to suspend the construction of some of them and reprofile them for the organization of a repair association.

In the general scheme for the development and location of plants for major overhaul of metal-working equipment, which was developed by the ENIMS [Experimental Scientific Research institute of Metal-Cutting Machines], provision is made for the setting up of a centralized repair enterprise in Central Kazakhstan. Such a coincidence of opinions at the ENIMS and the KazNIEIPiN, which are engaged in the development of the problem independently of each other, gives some weight to our proposal.

Under conditions of a limitation on capital investments the question of the creation of new enterprises is problematic. But it must be taken into consideration that during the extensive development of the national economy the repair subbranch was not developed to the required degree. Such a practice led to a great break between the organizational-technical levels of the main and the repair industries. The concentration of repair forces at specialized enterprises and plant-producers of the equipment is still an intensive path for the development of the subbranch which is under investigation.

Naturally, among some economists doubts arise about the advisability of creating new industrial plants: will the operation of the new plants be efficient enough? Actually in the machine-building industry of the Kazakh SSR by virtue of the predominance of small and middle-size enterprises, the cost for major repair of equipment is comparatively low. As an example, for the model IK62 engine lathe this index on the average is 36 percent of its initial cost. But we are losing out in the quality of repair by virtue of the absence of industrial conditions for carrying it out using industrial methods. And the non-machine-building enterprises which do not have a repair base are in an even worse position.

The problem of overhauling metal-working equipment in the republic will evidently be even more acute in the future due to the fact that USSR Minstankoprom will be directing the activity of repair plants on technical servicing and repair of NC machine tools. The difficulties in overhauling equipment will increase, since they become more and more complex as the technology progresses. All of this makes it possible to draw the conclusion: the demand of the republic's economy for specialized repair of equipment is great, it will grow and its structure will become more complex.

The enterprises of different branches will begin to use the services of the proposed repair plants, and the volume of work will be imposing. But for the convenience of the customers it is necessary to make a provision in the structure of their activity for on-site repair and issue of spare parts (rebuilding of worn-out parts) to a greater extent than this is practiced in the Minstankoprom plants which are in operation today. And also, in contrast to the existing analogous enterprises, they should have motor transport available.

Without a doubt the creation of the two repair enterprises will improve the situation, the serious position will be lightened significantly, and the greatest batch production of repair and the least expenditures for the overhaul of equipment will be achieved. At the same time the great distances which the equipment has to be shipped lower the advantage indicated considerably, namely, transportation expenses are great and service is lower.

Therefore in Kazakhstan for the purpose of bringing the executor closer to the customer it is necessary to set up a repair complex which consists of several plants. Calculations show that it is advisable to locate them also in the cities of Oktyabrsk, Serebryansk, and Lisakovsk in the Aktyubinsk, East Kazakhstan and Kustanay oblasts respectively. In order to assure the required batch nature of repair, at the last two sites there is the possibility of repairing metal-cutting machine tools from neighboring oblasts of the RSFSR.

The industrial-production personnel of the new plants should be made up of available workers from the repair services of the enterprises in the cities, since 30-35

percent of the volume of repair of the machine-tool pool should be performed under specialized conditions. Here the possibility appears of using the production facilities of the repair subunits of the plants which become available for increasing the output of goods that are in public demand. For example, in Karaganda—equipment for the coal industry, in Tselinograd—anti-erosion equipment, and in Pavlodar—commodities for public consumption.

Centralization of the repair of equipment in the south of Kazakhstan would make it possible to increase the production of rolling mills, metal-cutting machine tools, and spare parts for agricultural machinery in Alma-Ata, and in Chimkent—the automatic presses which are so necessary for the national economy.

Conditions will be created for the organization of a specialized association for repair, comprehensive modernization and adjustment of equipment, and it will become not only an industrial, but also an experimental and scientific-research base, a center for training of qualified personnel.

No one doubts the advisability of organizing company repair and servicing of equipment. In Kazakhstan the metal-cutting machine tools and forging and pressing equipment are produced by the Alma-Atinsk Machine-Building Plant imeni Twentieth Anniversary of October and the Chimkent Production Association for the Production of Forging and Pressing Equipment. For them it is necessary to organize company repair, and for this—to make provisions for additional machinery in the plans for reconstruction and technical refitting. At the present time reconstruction is proceeding at full speed at the ASZ. Unfortunately the organization of company repair is not planned here. In connection with this a thought occurs: why not create, on the base of this plant, an educational-scientific-production machine-building complex, which would solve all the problems connected with the manufacturing, use, and rebuilding of equipment? Moreso since the main prerequisite for it is here—the scientific-technical potential. The thinking is that it would be timely to make such an adjustment in the plan for restoration of production.

If the demand for equipment overhaul drops off, then with the investment of a small amount of capital from the assets for the development of production it is possible to convert a repair enterprise into a machine-building enterprise. And with the unprofitable maintenance plants which belong to the Gosagroprom [State Agroindustrial Committee] this can be done now fully or partially (taking into account the seasonal nature of loading of repair resources). Such a reorientation will make it possible to preserve the viability of the enterprise under conditions of self-support and self-financing.

Overhauling NC machine tools remains one of the acute problems faced by industry in the republic. The question of the creation of a center for technical servicing and repair of these machine tools in Alma-Ata and the corresponding sections in Karaganda, Pavlodar, Ust-Kamenogorsk, Chimkent and Aktyubinsk has come of age.

It has to be emphasized that in contrast to metal-working and wood-working equipment, agricultural equipment is supported by a wide network of repair enterprises, of which there were 147 in the republic at the beginning of the year. Their number is growing from year to year, but many of them do not have sufficient repair assets. It has to be acknowledged that the assets invested in the creation of repair plants and repair shops of Gosagroprom are not yielding the required return. This situation is explained by the fact that the sovkhozes and kolkhozes are endeavoring to overhaul the machinery with their own resources and use the services of the specialized enterprises reluctantly.

Equipment delivery also causes a lot of trouble, and the quality of repair is often unsatisfactory. After being given to the repair plants, the equipment frequently has to be finished up at the home facility. Therefore the demand for the manufacturing of spare parts for agricultural machinery at the RMZ [machine repair plant] is much higher than for the carrying out of repairs.

At four repair enterprises belonging to the Gosagroprom of the Kazakh SSR they are overhauling metal-cutting machine tools along with agricultural equipment. At the Remselmash production association they are repairing around 220 machine tools a year, at the Ushtobe Experimental-Test RMZ—200, at the Urals RMZ—120, and at the Smirnovsk Repair Plant—60 machine tools. We should increase the volume of equipment repair at these enterprises and use the industrial facilities of other repair plants of Gosagroprom for overhauling metal-cutting machine tools regardless of the department affiliation of the customers. They should also become centers for rebuilding worn-out parts, and for all types of equipment which is being operated in the neighboring territory.

The lowering of material, labor and monetary expenditures for overhauling equipment, and the intensification of the economy of the repair industry is a question of primary importance. Due to the absence of specialized plants for the repair of metal-working equipment in Kazakhstan the enterprises are forced to create a reserve of machine tools for taking care of the repair workers and the production of spare parts. This leads to a freezing of fixed assets, and a lowering of capital return and utilization coefficient of the equipment.

Physically and morally obsolete machine tools are still in operation, although the period between servicing has become 25-30 percent shorter and the cost of their major overhaul 15-20 percent higher than the established norms. Repair and subsequent operation of equipment which is completely worn out inflicts damage on the economy, which according to experts is on average

R2,170 annually for each metal-cutting machine tool. On the whole, in connection with this the national economy bears annual losses of more than R32 million.

The proposed interdepartment repair complex provides a considerable savings of state assets, accelerates the reorganization of the economy of the machine-building enterprises of the republic and aids in the adoption of the achievements of scientific-technical progress.

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Device To Prevent Vibrations of Piler Crane Column

18610167 Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 2, Feb 88 pp 15-16

[Article A.A. Molchanov, candidate of technical sciences, and M.Yu. Lavrenov, engineer]

[Text] Attempts have often been made to automate production equipment that is unsuitable for operation in an automated mode, that does not even operate reliably in a manual control mode, and that does not meet the basic requirements for a machine from the standpoint of existing automatic control systems [SAU] and equipment. This gives rise to the following completely natural question: What kind of automation can there be if there is not even a suitable control object?

This happens when domestic overhead traveling-type piler cranes [KSh] for long pieces of cargo are automated.

Nevertheless, information about automatic control systems for piler cranes periodically appears in the press. Such publications deal not with the fundamental possibility of automating this type of lifting and transport machine (an indisputable fact) but rather with the positive results obtained from implementing automatic control systems under production conditions. It is well known, however, that there are yet to be any piler cranes that function in an automated mode, either here or abroad.

It is not yet fundamentally possible to implement the concept of automatic machines. Specified prerequisites and conditions (already existing or required) of automation are needed. What are these prerequisites and conditions as they pertain to piler cranes?

The main obstacle to automating the piler cranes that are being manufactured by domestic industry is the impossibility of positioning them precisely.

The following are required to provide the positioning precision necessary for operation in an automated mode (for example, in the case of storehouses for long pieces of cargo the precision must be plus or minus 10 mm):

- changing from the sustaining speed to the drawing speed (positioning) with a speed ratio of no less than 5:1;
- maintaining the column's design position during operation and especially during positioning or, in the extreme case, guaranteeing that the column's deviation will not exceed plus or minus 10 mm.

When a two-speed induction electric drive or direct current controlled-velocity drive is used, the transition from the extension speed to the drawing speed is made by using the normal techniques.

When a one-speed induction motor is used (the exact type of drive with which type OKD domestic piler cranes are equipped), the crane must be lowered while it is in operation in order to attain its positioning speed, for example, by switching pole pairs. This goes against the values specified in the crane's documentation.

The main reason why the column (1) deviates from the design position is vibrations that act when the crane is started or stopped and are caused by the inertia forces of its moving masses and the cargo that it is transporting (Figure 1). When the crane trolley (2) moves, the column experiences a horizontal deviation $\Delta D_{h.t.}$ and a vertical deviation $\Delta D_{v.t.}$, and when the crane's gantry moves, the column experiences a horizontal deviation $\Delta D_{h.g.}$ and a vertical deviation $\Delta D_{v.g.}$. These introduce significant errors into the positioning of the load carrier at the junction of the crane's mutually perpendicular front and interrack paths of motion ($\Delta D_{v.t.}$ and $\Delta D_{h.t.}$) and at the specified positioning point ($\Delta D_{v.g.}$ and $\Delta D_{h.g.}$) along the passage between the racks.

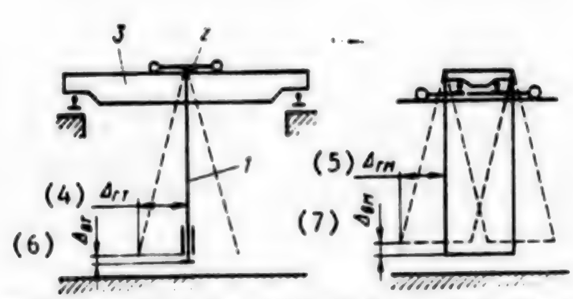

Figure 1. Diagram of the possible deviations in of the column of an overhead travelling piler crane.

Key: 1. Column 2. Trolley 3. Gantry 4. ΔD h.t. 5. ΔD h.g. 6. ΔD v.t. 7. ΔD v.g.

According to the existing empirical dependence, the calculated value of the horizontal deviation of the crane's column, with a normal load-lifting capacity Q, is

$$f_r = 0.005\sqrt[3]{Q}.$$

For example, a crane with a load-lifting capacity of 5 tons has a calculated horizontal deviation of 85 mm. However, the actual measurements of the deviation of the column of a type OKD-5 crane show that the real values of the specified indicator equal 300 mm.

Hence it follows that when the gaps between the crane and racks are controlled, it is not only impossible to automate the crane's movement along the passages, but it is also impossible for the crane to move along the passages unless measures are taken to keep the crane's column from vibrating.

The simplest way of eliminating the column's vibrations is to stop the crane and keep it still until the vibrations have completely or at least partially (to acceptable amplitudes, i.e., plus or minus 10 mm) subsided. The end result of this, however, is unproductive time expenditures and a loss in crane productivity. According to existing test data, even for an overhead travelling piler crane with a load-lifting capacity of 1 ton, the period needs for the vibrations to die down range from 35 to 40 s. Even more time is needed in the case of cranes with a greater load-lifting capacity. For this reason the specified alternative cannot be considered acceptable.

It is more rational to take special (including design) measures to dampen or, even better, to prevent column vibrations. The drive plays no small role in this. Smooth starts and stops can smooth out column vibrations substantially, but even this is not enough.

Devices such as two-roller balances, brake rollers mounted on the column's free end, and dynamic vibration dampers (especially electromechanical ones based on an electric drive that has special characteristics and is kinematically linked with the upper guide rail by means of a friction roller and load dampers in the form of some mass moving along the upper rail on their own trolley and connected to the upper part of the column by a damper) are currently being used for forced damping of the column's vibrations. Columns with an increased internal resistance have also been known to be used.

The aforementioned devices are not very efficient to use, and the resources expended are unjustified. It is therefore not feasible to use them in piler cranes.

In our view, the error in the developments that have been advanced thus far lies in the fact the devices created are generally intended to damp vibrations that have already arisen. What needs to be done is to solve the problem of preventing vibrations in the first place. One possible way of doing this is to use thrust rollers that stabilize the column's position by acting on their special guides (stops). In this manner, the column is prevented from deviating from its design position.

The main requirements for a similar stabilizing device are as follows:

- maintain the column's design position in all stages of the crane's functioning;
- enable the load carrier to switch in an unimpeded manner from moving along the front of the rack area (4) to moving along the passages between the rows of racks and also to allow the crane to pass from one flank (1) of the cargo area to another flank (2) through an inspection and cargo compilation area (3), for example, for long timbers (Figure 2).

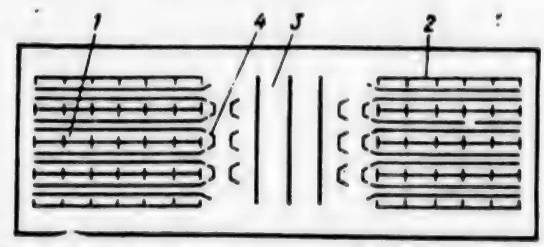

Figure 2. Plan of a two-area storage for large timbers.

For this, the thrust rollers (Figure 3) should be mounted in the lower free portion of the column (1) in pairs—one pair of rollers (2) (the front rollers) to stabilize the column when the load carrier moves along the front of the racks and there are perturbances caused by the crane's trolley and the other pair of rollers (3) (the interrack rollers) for stabilizing the column as the crane moves along the passageway between the racks and when there are perturbances caused by the moving crane.

Each pair of rollers (2 and 3) must be mounted at different levels along the height on which their respective guides are located, i.e., the front (4) and the interrack (5) guides.

There must be a sufficient distance at the junction of the front routes and the interrack passages to allow for the free passage of the front rollers along the front of the racks and for the interrack rollers when the cargo carrier passes into the passageway between the racks.

The guides shown as (5) may be made of an I-beam or two parallel mounted channels, and the other guides (4) may be made in the form of two channels that are paired along their height or two parallel channels with a height that is twice that of the guide (5). At the end of each of the guides there should be an expanded winding mechanism for the rollers.

The rollers act simultaneously. In the initial position (the starting position) when there are no disturbing actions between the rollers and the bearing surface of the guides, the gap should be on the order of 10 mm.

In the presence of a disturbing effect, the rollers are pushed to the upper flange of the respective guides.

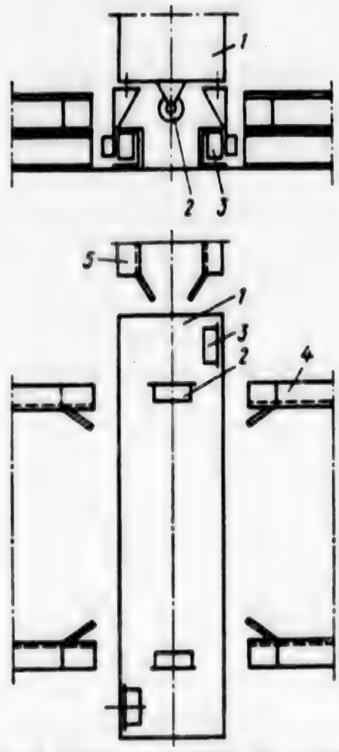

Figure 3. Device to stabilize the position of a crane's column.

Implementing this device for stabilizing the column of an overhead travelling piler crane and a two-speed drive or one with continuous velocity control in the mechanisms moving a crane's trolley and gantry makes it possible to eliminate the factors that stand in the way of automating piler cranes and creates a minimum amount of prerequisites for implementing management automation systems [ASU] for storage.

Piler cranes cannot be automated unless the problem of precise positioning is solved.

The device for stabilizing the position of the column of an overhead travelling piler crane was used in developing measures to provide the requisites for automating storages for long pieces of cargo.

In conclusion, it should be stressed that it is only possible to automate those pieces of equipment that have demonstrated their high operating reliability and adequate efficiency when operated in a manual control mode. Otherwise, a piece of equipment must be painstakingly prepared (for example, by repair, adjustment, or even updating) before it can be switched to an automatic control mode.

Selecting (designating) a piece of equipment for automation in an unfounded manner not only causes a quandary but also inflicts serious harm to production and discourages the very idea of automation.

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Electromagnetic Field as Factor in Increased Lifetime of Metal-Polymer Materials

18610108 Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 31, Nov 87 pp 999-1001

[Article by V.A. Goldade, Institute of Metal-Polymer Mechanics of the BSSR Academy of Sciences; presented by the Academician of the BSSR Academy of Sciences V.A.Belyy]

[Text] At the present time, when reserves for improving the operational parameters of the materials used in machine building are to a significant degree exhausted, further improvements in the performance of machines is connected with adapting of materials to the service conditions. Modern machine building requires materials based on metallic, polymer, and ceramic matrices, the structure and properties of which are automatically controlled under the influence of changing operational factors.[1-3]

It is known that many structural and process materials change their properties under the influence of physical fields. For example, as a result of irradiating parts in a charged particle flux, and also by facilitating electrochemical processes in the friction zone, it is possible to substantially decrease material wear in friction joints.[4-6] Seals with liquid-metal and ferrous fluid working media with viscosity, density, and other properties being changed by applying a magnetic field depending on the required leak-tightness[7-8] are used in aviation, space technology, and power engineering. Control methods using material electromagnetic fields of conductivity and crystal polarization, semiconducting material conditioning, etc., are known.

This work analyzes the possibility of increasing the efficiency of metal-polymer assemblies using electric and magnetic fields.

Metal-polymer assemblies (MPA) are combinations of metal and polymer parts working together.[11] MPA performance is determined by its design, properties of the materials it is made of, and service conditions, that is, temperature, pressure, speed of relative displacement of parts, and influence of media, physical fields, radiation, etc. In use, MPA lead to changes in material structures and wear of parts, which lowers the performance and service life of the joints.

Specifically, MPA are made up of electrode element-metals and polymer materials which have electrolytic properties and, being at the same time dielectrics, are polarizable under the influence of an electric field.

The negative influence of operating conditions on MPA performance may be reduced by using electric and magnetic fields. Using electric polarization, it is possible to modify the polymer materials structure, improve strength parameters, increase corrosion resistance and adhesion, and to reduce permeability.[12]. Under the influence of a magnetic field, an orientation of the particles of the magnetically hard filler or the structural units of the polymer material takes place, which leads to structural modification and change in operational characteristics of the polymer composites.[8] In general, use of an electromagnetic field allows one to control the structure of surface layers of contacting parts and, therefore, to control the MPA components interaction.

The problem of improving MPA performance may have an effective solution only if the electromagnetic field is turned on when the operating conditions are changed, that is, in the case of a closed-loop servo system with feedback tracking the changes in the MPA operational conditions and activating the electromagnetic field. The result of the control action may be the electric polarization of the polymer, shift of the metal electrode potential, and orientation of the particles of the filler or the structural units of the polymer material, which leads to lubrication, reduction in the permeability of the seal, and so on. The feedback is realized through the operational conditions: their change initiates the control action of the electromagnetic field.

Let us examine on concrete examples the possibility of controlling MPA performance using electric and magnetic fields.

One of the problems of reducing the corrosion-mechanical wear of machines is the development of reliable and small sources for the electric polarization of the friction joints. A metal-polymer assembly friction joint is proposed[13] consisting of a shaft and a bushing installed in the frame. The bushing is a package of 3 coaxial bushings, where the middle one is made of polymer, and the two others are made of metal, the bushing adjacent to the shaft being made of a metal possessing a more positive electric potential. The design allows one to use the friction heating of the assembly for generating a current in the metal 1—polymer—metal 2 circuit, which leads to a shift in the shaft electrode potential into the region of passive values and provides its electrochemical protection without the use of outside electric sources. As a result, it is possible to reduce corrosion-mechanical wear of a steel shaft.

The wide possibilities of controlling material properties during the operation of machines are realized by using composite magnetically controlled materials based on polymers and magnetic fluids,[8] as well as polymer materials containing instead of a magnetic fluid a liquid metallic filler.[14] In the latter case, the liquid metal serves as a sensing element reacting to changes in exterior factors by moving in the gap between the poles of an electric magnet, as a result of which automatic control of the Lorentz force upon changes in pressure is realized. The contact seals of these elements operate in the range of pressure differentials from higher-than-atmospheric to vacuum, thanks to control of leak-tightness and lubrication.

Using lubricants based on polyethylene and oil and containing ferromagnetic particles as a modifying additive,[15] it is possible to observe the changes in the operating conditions of the friction joint. At friction joint temperatures below 385 deg K, the lubricating layer has a structure of a porous matrix based on polyethylene with a colloid solution of ferromagnetic particles enclosed in the pores of the matrix. Such a structure is stable against being squeezed out of the friction zone under the influence of excessive pressure of the pressurized medium. At temperatures above melting temperature of the polyethylene matrix, superposition of an exterior magnetic field leads to a specific orientation of magnetic particles thus increasing the viscosity of the lubricant. In this case the result of the control action of the magnetic field causes improved lubrication and reduction in the sealing element permeability, which increases the reliability of the friction joint operation at elevated temperatures.

Thus, an electromagnetic field affects the physical-chemical processes of polymer and metal interaction in the MPA, providing control of the surface layers structures of the interacting parts, which provides capability for controlling joint performance during changes in its operating conditions.

Footnotes

1. "Fizicheskoye materialovedeniye v SSSR: Istoriya, sovremennoye sostoyaniye, perspektiviy razvitiya" [Physical Material Science in the USSR: History, Contemporary State, Development Outlook],edited by V.I. Trefilov and I.N. Frantsevich, Kiev, 1986, 584 p.

2. Belyy, V.A. and Sviridenok, A.I., TRENIYE I IZNOS, Vol 8 No 1, 1987, pp 5-24.

3. "Materialy budushchego" [Materials of the Future], translated from German, edited by A. Neumann, Leningrad, 1985, 240 pages.

4. Silin, A.A., "Treniye i ego rol v razvitii tekhniki" [Friction and Its Role in Technology Development], Moscow, 1983, 176 p.

5. Garkunov, D.N., Kragelskiy, I.V. and Polyakov, A.A. "Izbiratelnyy perenos v uzlakh treniya" [Selective Transfer in Friction Joints], Moscow, 1969, 163 p.

6. Litvinov, V.N., Mikhin, N.M. and Myshkin, N.K. "Fiziko-khimicheskaya mekhanika izbiratelnogo perenosa pri trenii" [Physical-Chemical Mechanics of Selective Transfer During Friction], Moscow, 1979, 186 p.

7. Khadiyev, M.V., "Obzornaya informatsiya. Kompressernoye mashinostroyeniye, Seriya KhM-5" [Review Information. Compressor Machine Building, Series KhM-5], Moscow, 1979, 37 p.

8. Goldade, V.A., Neverov, A.S. and Pinchuk, L.S. "Nizkomodulnyye compozitsionnyye materialy na osnove termoplastov" [Low-Modulus Composite Materials Based on Thermoplastics], Minsk, 1984, 231 p.

9. Lines, M. and Glass, A. "Segnetoelektriki i rodstvennyye im materialy" [Ferroelectrics and Related Materials], translated from English, Moscow, 1981, 736 p.

10. "Elektrety" [Electrets], translated from English, edited by G. Sessler, Moscow, 1983, 487 p.

11. Belyy, V.A. and Pleskachevskiy, Yu.M. VESTSI AN BSSR, SER. FIZ.-TEKHN. NAVUK, 1978, No 4, pp 57-65.

12. Goldade, V.A. and Pinchuk, L.S. "Elektretnyye plastmassy: fizika i materialovedeniye" [Electret Plastics: Physics and Material Science], Minsk, 1987, 231 p.

13. Pinchuk, L.S., Voronezhtsev, Yu.I., Goldade, V.A., et al., Certificate of Authorship No 1055913 (USSR), BYULLETEN IZOBRETENIYA, No 43, 1983.

14. Belyy, V.A., Goldade, V.A., Neverov, A.S. and Pinchuk L.S., Certificate of Authorship No 709878 (USSR), BYULLETEN IZOBRETENIYA, No 2, 1980.

15. Goldade, V.A., Neverov, A.S., Pinchuk, L.S., et al., Certificate of Authorship No 925996 (USSR). BYULLETEN IZOBRETENIYA, No 17, 1982.

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Mechanization, Automation in Ship Industry

18610024 Leningrad SUDOSTROYENIYE in Russian No 7, Jul 88 p 41

[Unattributed article: "Mechanization and Automation of Production"]

[Text] A technological complex for construction of composite docks envisions a flow line process of formation of L-shaped dock halves at six stations, followed by joining them together while floating. A part of the line 66 m long (three stations) is located in the shiphouse: here the ferroconcrete half-pontoon is assembled by successive joining and moving through the stations. A second part of the flow line (140 m) is located outdoors, where the metal towers are assembled and joined to the half-pontoon and the finishing work is done. Each station has installed process equipment, suitable to the work being done. For the first station, this is a stacking jig, enabling placement of the sections in the required position without layout and checking steps, and welding equipment to join the reinforcement rods together; for the second, bottom and side forms with pneumatic actuator; for the third, systems testing the water tightness of the compartments, and so on. The flow line in the shiphouse is serviced by two bridge cranes; the outdoor section by a

gantry crane. Adoption of a complex with sequential movement of the finished part of the hull outside the shiphouse freed up a sizable area of production space, provided a well-paced process cycle, and doubled the output of docks. This construction complex has been given inventor's certificate 1039796.

A unit for assembly of modules, consisting of a traveling manipulator platform and a turntable, is used to form three-dimensional hull structures of various types of transportation ship. For ships with lengthwise bulkheads, these are gunwale modules; for those without, complete modules. The maximum dimensions of the resulting structures are 24x24x31 m, the minimum 8x8x16 m. For the majority of full-contour vessels, the assembly is done by consecutive joining (using the manipulator platform) of the other sections to the transverse bulkhead, mounted on the turntable. Assembly of the complete modules of liquid-gas carriers is done in the traditional position. For multi-deck vessels, an additional load-lifting device is used as well as the unit for consecutive assembly of the interior structures of the module. The unit affords high precision of mechanized assembly of modules and reduces assembly deformations.

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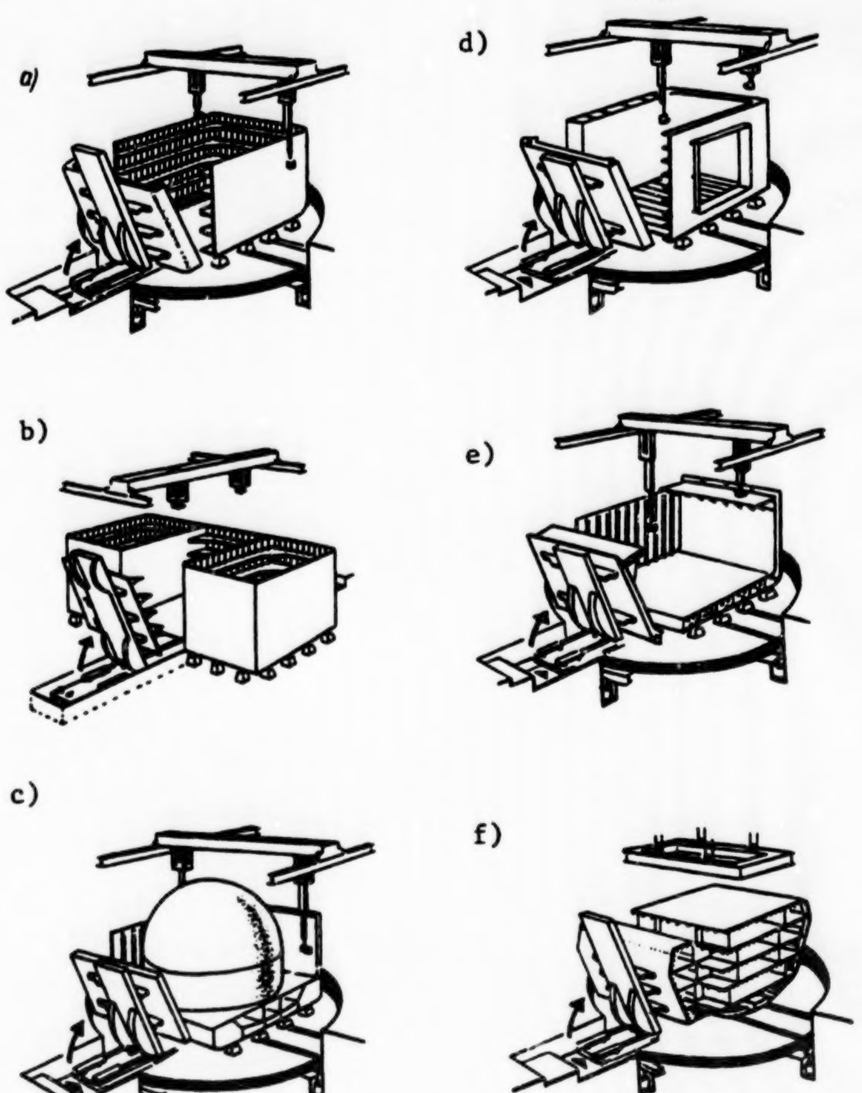

Using the unit for assembly of transportation ship modules

Key: a) Assembly of a gunwale module; b) Assembly of a complete module with lengthwise bulkheads; c) Assembly of a liguid-gas carrier module; d),e) Assembly of a complete module of s single-deck ship; f) Same, for multi-deck ship

Construction of Underground Compressor Station at Pavlodar Tractor Plant

18610154 Moscow BETON I ZHELEZOBETON in Russian No 3, Mar 88 p 17

[Article under the "At the Exhibition of USSR National Economic Achievements" rubric: "Construction of a Compressor Station"]

[Text] The underground portion of the compressor station for industrial wastewater from the Pavlodar Tractor Plant is a round structure with an inner diameter of 24 m and with a mark indicating the lower part of the bottom at 11.8 m. According to the initial plan, the underground portion was supposed to be a caisson with a wall thickness of 1.8. However, the complicated hydrogeological conditions in the construction site necessitated major material and labor outlays related to water drainage and sinking the pump house casing.

A design for the configuration of the outer walls of the structure based on the "wall in soil" technique and made from prefabricated and cast-in-place structures in the form of bilayer panels was researched and developed at Soyuzspetsfundamenttyazhstroy NPO [All-Union Special Foundations or Heavy Construction specific production association]. One of its components is a series of precast reinforced concrete elements with projections for a reinforcing cage. The other component, a cost-in-place component, is concreted under a clay suspension directly in a trench. Precast reinforced concrete panels, 10x1.2x0.24 m in size, with projections for longitudinal and transverse reinforcement are used in the combination precast and cast-in-place underground section. The cast-in-place section is 33 m thick. Sections of a cast-in-place "wall in soil" have been arranged in the places where large-diameter stuffing boxes have been installed. A push rod clamshell that was built at the Voronezh Excavator Plant on the basis of an EO-5122 excavator with a bucket width of 0.6 m was used to dig the trench. A clay suspension with a bulk density of 1.15 to 1.16 g/cm^3 that was prepared by using local clays from the Yermakov open-pit mine was used to stabilize the trench walls.

A front shaft made of concrete foundation blocks had to be erected to stabilize the top of the trench and the directed motion of the clamshell. An RDK-25 crane was used to install the precast reinforced concrete panels. The panels were hung on the front shaft with the help of short flange beams and seat angles, and the detents for concreting the cast-in-place section were divided with pipes.

The cast-in-place portion of the wall was concreted by using the vertically moving pipe [VPT] method with a concrete-pouring pipe and a loading hopper. A vibrator was attached to the lower end of the pipe, which made it possible to use a concrete mixture with a cone slip between 8 and 12 cm.

The proposed method made it possible to reduce construction costs by R 52,000, cut the construction time in half, and save 65 tons of cement and 26 tons of reinforcement. The Pavlodarpromstroy SU-1 trust constructed the compressor station.

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Computer Exhibition-Seminar Promotes USSR-Romanian Cooperation

18610073c Kiev PRAVDA UKRAINY in Russian No 216, 18 Sep 88 p 2

[Article by T. Larina, correspondent]

[Abstract] Kiev, 17 Sep—The Ukrainian Academy of Sciences' Institute of Cybernetics imeni Glushkov has bought 20 modern personal computers and peripheral equipment for them from Romanian colleagues. This deal is one result of an exhibition-seminar, "Personal Computers and Computer Equipment of the Socialist Republic of Romania," which has concluded in the capital of the Ukraine.

"Strange as it may seem, an institution which itself is developing modern computers and software is forced to acquire computer equipment, especially personal computers, abroad," said Doctor of Physical-Mathematical Sciences F. I. Andon, deputy chairman of the exhibition's organizing committee and director of the institute's special software design and technological bureau. "This is a consequence of the fact that our industry has lagged in the field of mass production of such computers."

The personal computers were not the only thing that aroused the visitor's interest. They noticed versatile units of the minicomputer class for automated production-process control systems, management information systems for enterprises and scientific research, and a number of devices for work with engineering drawings and other graphic representations, for example.

Contracts connected with acquisition of computer technology were prepared by representatives of other scientific institutions of our country. The work of the exhibition-seminar, which was the first of its kind to be organized, was not confined to this, however. Problems of the advancement of cybernetics were broadly discussed here, as were questions of scientific-technical cooperation between Soviet and Romanian specialists and joint development of new computer equipment. After being familiarized with the cybernetics institute's work, the guests inquired about results of research in such fields as medicine, artificial intelligence, and software for management information systems for scientific research, computer-aided designing systems, and other systems.

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